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Engineering NEWS-RECORD

September 2, 1937

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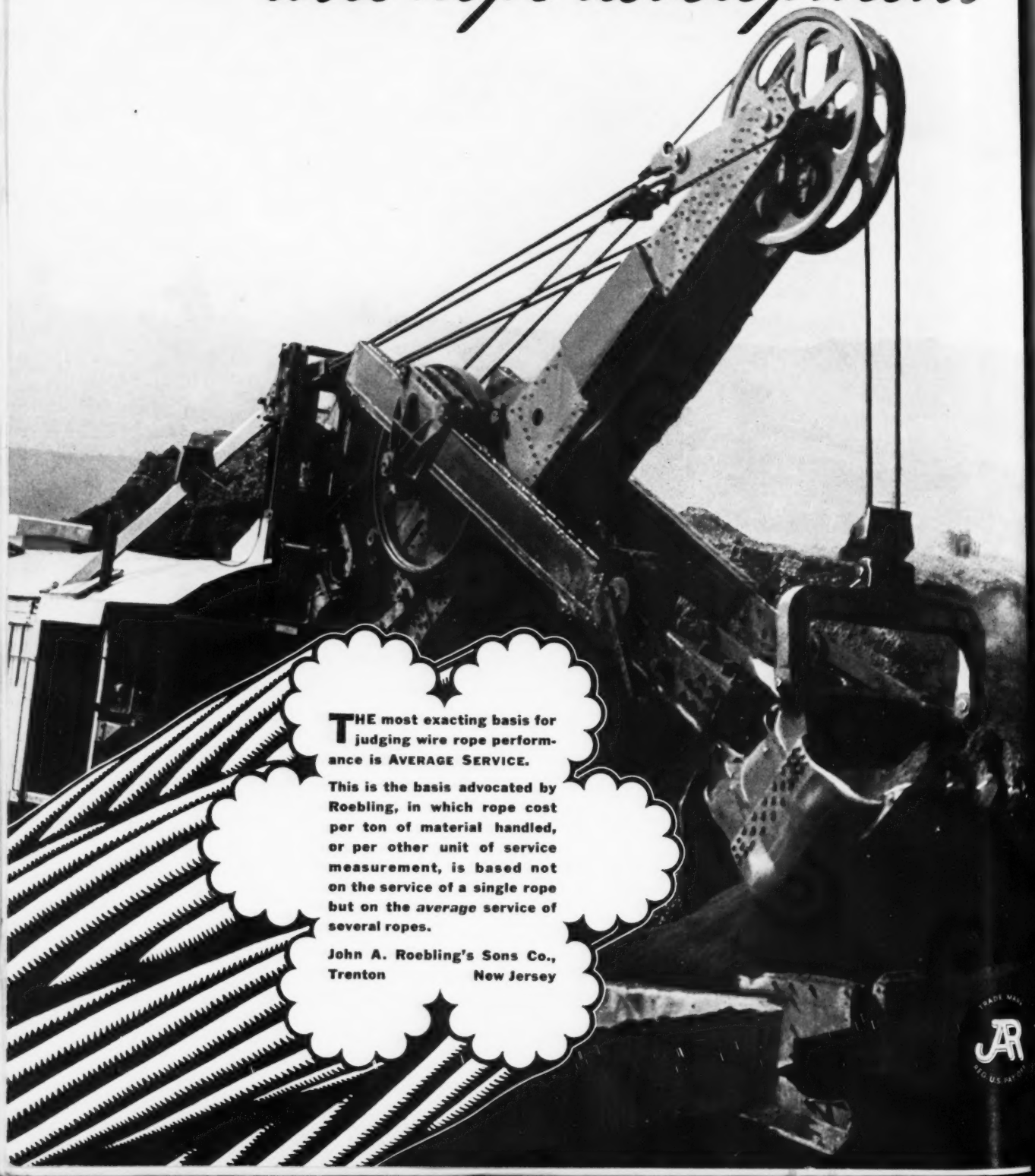

THE most exacting basis for judging wire rope performance is AVERAGE SERVICE.

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Bigtown Talks Back

SOME WEEKS AGO, under the head "On Making and Taking", this page spoke against the practice of restricting public purchases on some "buy-at-home" basis. It made the point that the great progress of our people has been due in large measure to the free trade that prevails between producers in every section of our vast domain.

To lend color to the comment, it cited, under the alias of "Bigtown", an important city which prides itself on the world-wide use of its products and at the same time enforces certain restrictions in its community buying. The purpose of the alias was to avoid singling out this particular city for criticism: as a matter of fact, its restrictions are mild as compared with those of other communities.

HOWEVER, it appears that some sharp eyes saw right through the false whiskers and identified the city they were intended to conceal. So it seems only fair that the city should have a chance to say its say; and here is a statement composed of extracts from two letters sent to this writer by responsible spokesmen for the city.

> "I appreciate the point that you make about the danger of building economic walls around political units. I agree that the free flow of trade between states and nations is the foundation of economic prosperity. The artificial barrier of tariffs and trade restrictions is a dangerous device in the long run.
>
> "We in so-called Bigtown have consistently declined to take part in any of the agitations popular in recent years, such as Buy Hometown; Buy Home State; Buy America. On the other hand, we do believe in charity beginning at home even with reference to municipal purchases, PROVIDED all factors are equal: quality, price and service.
>
> "Is it unreasonable to give preference to Hometown or to Home State, if quality, price and service are equal or better? An industry located in Hometown or even in Home State helps to pay a part of the bill for such materials, namely, through taxation and through the wages of its citizen workers who, in turn, pay taxes. The policy of Bigtown is not discriminatory because of the explicit requirement that 'all things be equal.'
>
> "Our purchasing policy is the result of an informal expression adopted by our Council in 1935. Where bids are equal, the product made in the city is given first preference; in the county, second preference; in the state, third; and out of the state, fourth. Should there be more than one equal low bidder in any of the classifications noted, they are given an opportunity to meet in the office of the director of purchases and supplies at an hour fixed by him, to settle and agree among themselves forthwith as to which one shall receive the award of the contract. Insofar as the policy and practice of our department of purchases and supplies is concerned, equal bids means equal in price, quality and service. Of course, the bidders must also be responsible bidders.
>
> "Your article notes that if materials are manufactured within the state, the city will bear the cost of inspection, whereas if they are manufactured elsewhere, the contractor must pay the inspection charge. This is not so. The provisions of our specifications are to the effect that the city will bear the cost of inspection if the materials are manufactured within fifty miles of Bigtown. This radius covers three states and sweeps one of the most densely populated sections of the eastern coast. If any fair area can be designated, this is, I think, the fairest. The fifty-mile provision is a generous one.
>
> "If the exercise of either policy of Bigtown were discriminatory or prejudicial, criticism would be merited. However, Bigtown's bidders are not given any preference unless quality, price and service are at least equal."

This writer is glad to have these corrections and comments and to pass them on to all who may be interested.

Willard Chevalier

ENGINEERING NEWS-RECORD

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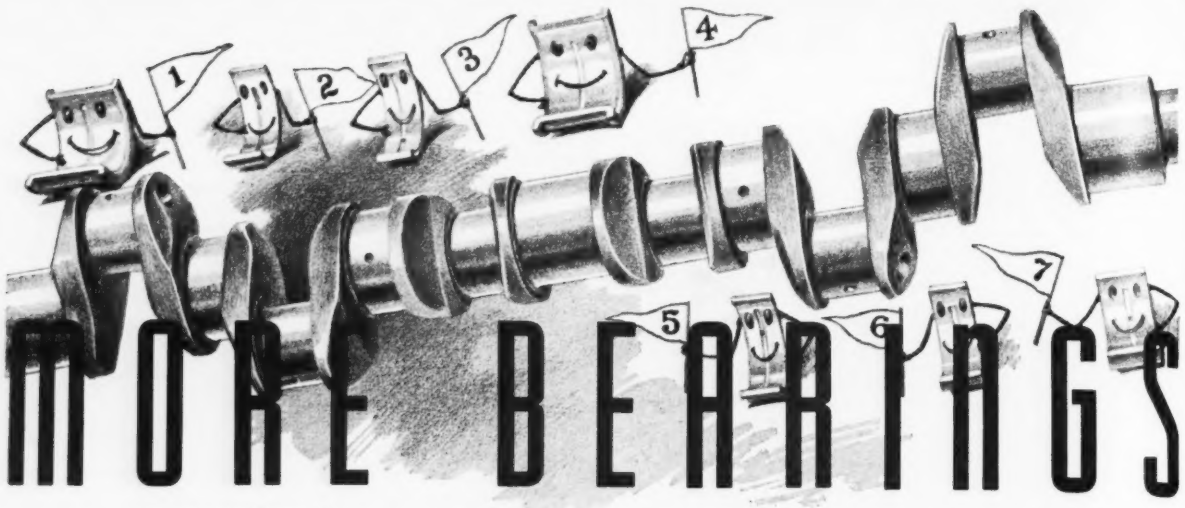

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THIS WEEK AND NEXT

COLORADO'S FAMOUS Moffat Railroad across the high Rockies is being rehabilitated from a decrepit, bankrupt property into a first-class line by an extensive improvement program. It is a real come-back story that is told in this issue.

There is also told the story of a railroad that didn't come back. Flagler's Key West Route, the railroad that "went to sea", was literally blown out of service by the Labor Day hurricane of 1935. Its 33 miles of bridges and roadbed are being rebuilt as a toll highway.

Financial failures suggest better construction cost keeping. How to organize job records so that costs are known at all times is outlined by H. P. Maxton. It is a What-Every-Contractor-Should-Know article.

But, after all, economy begins on the drawing board. Given a certain opening, such as a building foundation or a bridge, what arrangement of beams requires the least steel? A bit of fundamental thinking on this recurring problem is contributed by George Booss, Jr.

Dean Warren of the General Electric Co. carries on the highway lighting series with a description of road model investigations, later checked by actual road tests, which show how to place and space lights.

NEXT WEEK—Shipping and hurricanes combine to make the new Neches River Bridge job below Port Arthur, Texas, one of the most interesting in the country. Shipping requires a 176-ft. clearance; result: bridge is 7700 ft. long including approaches. Hurricanes may cause a 75-lb. per sq.ft. side load; result: batter piles and spread leg towers. In the foundation story next week, the ingenious pile driver, the access canal across the salt marshes and the "sand-island" piers are features.

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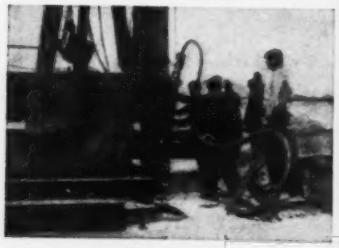
COVER PICTURE—Working a 200-ft. quarry face in an old volcano to secure cinder ballast for the Moffat Railroad in Colorado.

JAEGER Offers to Contractors . . .

WELL POINT SYSTEMS

DRAINAGE JOBS



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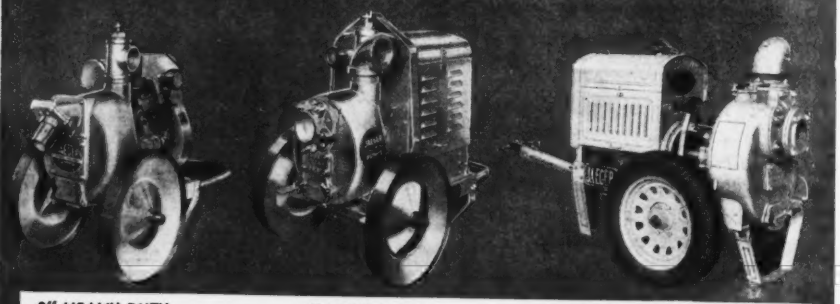

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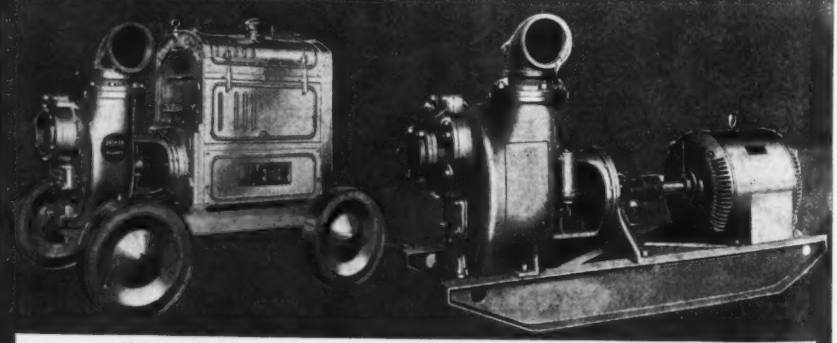

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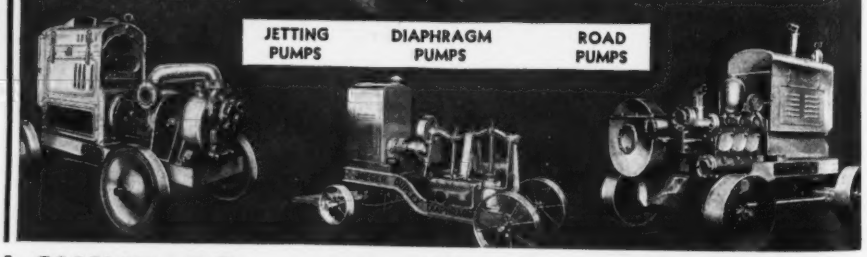

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THE WEEK'S EVENTS

Works Department Not Approved

Brookings report disapproves public works department but would remove civilian functions from War Department

Most public construction is incidental to larger purposes not directly of a construction nature, and there is therefore no justification for setting up in the federal government a department of public works, the Brookings Institute has reported to the select Congressional committee investigating the executive agencies of the government with a view to their coordination. This opinion was embodied in the fourteenth of the Brookings reports, covering public works and water resources.

The report finds that "The wide diversity of the functions [involved in public works construction] makes it impossible to unite them all in a single department simply because their administration utilizes personnel, techniques and equipment that are vaguely grouped under the heading engineering and are therefore assumed to be characterized by interchangeability. . . The creation of a central public works organization to undertake all construction for the federal government does not appear to offer any advantages either in economy or efficiency. Two reasons why these conclusions have been reached are: that engineering and construction work in the national government is generally a process incidental to the exercise of a broader, more general function; and the work is so diverse in character that it requires different types of specialists."

The report goes on to state that, since the engineering activities of the government fall into distinctive fields, a public works department would have to be subdivided on the basis of these fields, so that no actual saving could be realized through combination or interchange of personnel. Moreover, each of these subdivisions would have to have its own separate regional organization since such activities as, say, the lighthouse service and the Bureau of Public Roads, could obviously not use a similar regional set-up. And since the greater part of the government construction work is done on private contracts there would be little opportunity, in the view of the institute, for economy through the pooling of equipment; and even work done directly by the government requires specialized equipment for different types of work, and the equipment is usually of a heavy nature which cannot be moved economically except for relatively short distances.

Finally, the report states, "Neither the ascertainment of the need for new construction nor the operation of completed structures include functions which could properly be exercised by a public works construction agency. . . . Engineering is an auxiliary service, in the same category as legal advice or accounting, so the distribution of engineering units among agencies requiring their assistance does not necessarily constitute undesirable duplication."

Rather than recommending a centralized construction department, the report suggested that various types of construction work should be split up among the agencies of the government to which they most logically belong.

River and harbor improvement and highway development, in the view of the institute, are primarily transportation functions and should be dealt with accordingly. River improvement projects in which navigation is of secondary importance should be entrusted to a separate engineering organization located in the same department as the Bureau of Reclamation. The Corps of Engineers of the War Department should be relieved of its non-military responsibilities.

The Bureau of Reclamation would be located either in the Interior Department or a department of land use.

The public building branch of the Procurement Division should be transferred to a proposed new general supply service and should be made responsible for the construction and maintenance of all major public buildings including those of the National Park Service.

Resettlement Administration housing projects should be transferred to the Housing Division of the PWA or, if

(*Continued on page 372*)

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• • •

PWA Allotments Pass Hundred Million

Seven hundred sixty PWA allotments made August 24-30 have brought the total allotments under the new 1937 PWA program to $118,405,000. This is made up of grants of $97,474,000 and loans of $19,931,000. These figures include the 350 schools, allotments for which are noted on page 405 of this issue and the $20,000,000 allotment for power projects in Nebraska noted on page 370.

Total construction permitted by the new program to date has an estimated value of $220,461,000.

The new allotments include 24 more school projects, for which grants of $1,437,000 and loans of $542,000 have been made.

Most of the new allotments are for small projects. Among the exceptions are a grant of $1,948,000 and a loan of $2,382,000 for a $4,330,000 electric plant at Chattanooga. Chicago has received a grant of $880,000 for a $1,955,000 memorial building. A grant of $818,000 has been made to Houston for a city hall costing $1,818,000. Waterworks at Lake Wisconsin costing $1,300,000 received a grant of $585,000. A grant of $4,000,000 has been made to Sacramento, Calif., for $12,000,000 of work on an electric distribution system. This project consists of the erection of a steam generating plant and the construction of a distribution system.

Nebraska Project Gets Allotment

Tricounty District receives $20,000,000 allotment from PWA for Keystone Dam

Public Works Administrator Ickes on Aug. 26 announced approval of a $20,096,000 allotment to the Central Nebraska (Tricounty) Public Power and Irrigation District to complete its program of power development. The allotment includes a grant of $9,043,000 and a loan of $11,053,000.

The allotment will be used to complete Keystone Dam, to construct the Jeffrey Canyon Power Plant and the Johnson Canyon Power plant and to erect transmission lines.

Work on the Central Nebraska program was started in 1935 with an allotment of $10,000,000, which is now being used for construction of irrigation ditches and for the initial construction on Keystone Dam.

The Tricounty project is one of five projects comprising the "Nebraska grid." The development is based on construction of the Keystone Dam, which will be the second largest earth dam in the world, exceed in size only by Fort Peck. Water from the dam passes through the North Platte River to a point just below the South Platte River where it is diverted into a power canal, passes through the Jeffrey Canyon power house, enters a second portion of the power canal, and is returned through the Johnson Canyon power house to the Platte River.

Coordination of projects

It is reported that negotiations are now in progress by which Nebraska public authorities would purchase the major private utilities in the state, creating the first state-wide publicly owned power system in the country.

The three large power districts in Nebraska, the Platte Valley Power and Irrigation District, the Central Nebraska District and the Loup River District have arranged to employ Arthur Wellwood as consultant and coordinator for the three districts. Mr. Wellwood has been PWA project engineer for Nebraska. He is resigning from his position with PWA to take his new post.

• • •

Painters Strike In New York

A general strike of all union painters throughout the city of New York except in Brooklyn was called Aug. 26 by the Brotherhood of Painters and Decorators, A.F. of L. affiliate. About 15,000 men are out, and painting and decorating jobs in the affected area are at a standstill. Early extension of the strike to Brooklyn is expected.

The union is striking for a 30-hour week with a 6-hour day at a minimum rate of $1.75 per hour or $10.50 per day. It is also demanded that the union control at least 50 per cent of hiring in order to eliminate the kick-back. The contract which expired Aug. 26 called for a 35-hour week and pay of $9 for a 7-hour day.

Efforts to settle the strike are under way by the State Mediation Board and the labor relations department of the PWA. PWA is involved because the strike has interfered with work on the Williamsburg and Harlem housing projects in New York City. A number of other PWA projects in the city are affected, and if the strike is prolonged it is believed it would affect PWA projects in other cities where the painting work is being done by New York contractors.

Housing Projects Ready to Go

Many pending projects can be started immediately under terms of Wagner Act

When the U. S. Housing Corp. authorized by the Wagner housing act gets organized, it will find plenty of work waiting. PWA has ready for transfer 62 housing projects approved by its housing division but never carried through because of lack of funds and other difficulties. In addition, it has received 312 applications for consideration under the new law. State laws permitting the formation of local housing authorities have been enacted by 30 states.

A $24,000,000 program of housing is planned by the newly created Pittsburgh Housing Authority, created under the terms of a state law passed at the last session of the legislature. Included in the proposed projects are an $8,000,000, 1,300-unit project and a $3,000,000, 600-unit project. Other plans would provide for 1,600 units at a total cost of $13,000,000.

Rentals announced

The Housing Division of PWA has announced the rentals which will be charged in two more of its housing projects. At Cherokee Terrace, $557,000 project at Enid, Okla., rentals will average from $17.90 to $25.00 per month for three to five-room dwellings. Utility charge will range from $5.50 to $6.50 per month.

For dwellings in the $1,020,000 Cedar Springs Place project at Dallas, monthly rentals will range from $14.79 for a two-room unit to $25.40 for a five room unit, with a service charge averaging from $5.25 to $6 per month.

ENGINEERING CONSTRUCTION CONTRACTS REPORTED BY *ENGINEERING NEWS-RECORD*, IN AUGUST, 1937

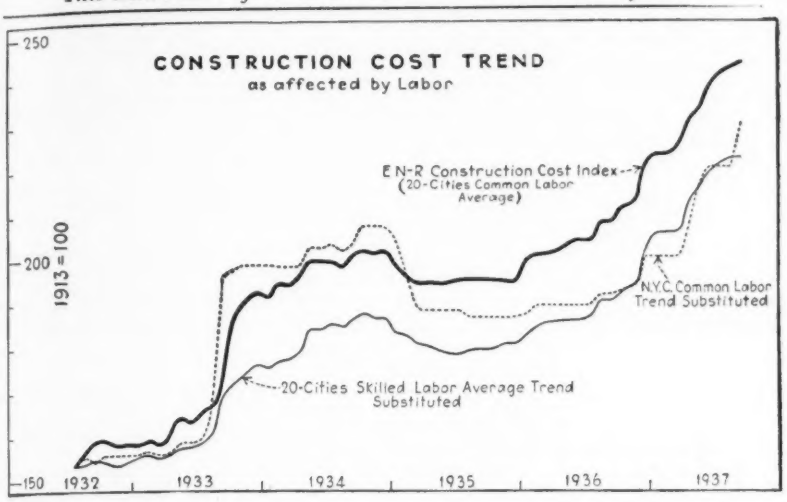
Engineering News-Record *reports projects of the following minimum costs: Water-works, excavation, drainage and irrigation*, $15,000; *other public works*, $25,000; *industrial buildings*, $40,000; *other buildings*, $150,000.

Four Weeks — Thousands of Dollars (000 Omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States August 1937	United States Eight Months 1937	United States Eight Months 1936	Canada
Public Works										
Waterworks	174	621	447	572	394	951	**3,159**	49,769	72,236	350
Sewerage	97	4,411	42	624	2,171	519	**7,864**	64,998	90,044	155
Bridges	734	2,714	166	2,109	539	879	**7,141**	81,805	118,263	305
Earthwork and waterways	340	634	865	1,050	2,779	10,269	**15,937**	71,667	129,780	11,655
Streets and roads	2,094	7,958	6,640	11,262	7,515	4,800	**40,269**	273,749	329,247	2,452
Buildings, public	1,430	10,617	2,788	2,366	3,546	609	**21,356**	219,049	328,625	2,032
Unclassified, public	373	1,264	172	1,552	2,218	2,344	**7,923**	104,602	66,625	420
Total public	**5,242**	**28,219**	**11,120**	**19,535**	**19,162**	**20,371**	**103,649**	**865,639**	**1,134,820**	**17,369**
Federal government (included in above classifications)	668	4,327	1,616	1,615	3,602	7,966	**19,794**	134,332	227,599	.....
Private										
Bridges, private	.....	165	.....	.....	25	.....	**190**	5,841	9,043	.....
Buildings, industrial	3,570	6,485	7,618	11,780	3,847	1,890	**35,190**	372,394	171,063	**2,665**
Buildings, commercial	500	15,366	1,708	4,430	1,875	841	**24,720**	310,589	142,987	687
Unclassified, private	40	1,414	620	706	1,830	1,709	**6,319**	121,034	82,374	84
Total private	**4,110**	**23,430**	**9,946**	**16,916**	**7,577**	**4,440**	**66,419**	**809,858**	**405,467**	**3,436**
Total Engineering Construction										
August, 1937 (4 weeks)	**9,352**	**51,649**	**21,066**	**36,451**	**26,739**	**24,811**	**170,068**	.....	.....	**20,805**
July, 1937 (5 weeks)	11,280	108,398	30,397	49,285	36,352	24,289	**260,001**	.....	.....	11,214
August, 1936 (4 weeks)	7,203	60,850	24,291	39,726	34,664	25,583	**192,317**	.....	.....	10,221
Eight months, 1937	79,979	761,350	162,127	269,756	232,207	170,078	.....	1,675,497	.....	93,596
Eight months, 1936	101,427	479,631	196,798	271,954	299,388	191,089	.....	.....	1,540,287	63,356

THE CURRENT TREND

This week's news of contract volume and construction cost factors



Labor Rules the Cost Waves

Construction costs, measured by the *ENR* Construction Cost Index increases one point this month to 243.95, due to a substantial rise in common labor rates in New York City. Since 1935 the *ENR* Construction Cost Index rise has been steady and sustained, with labor setting the pace. Steel and lumber have stepped up the curve at intervals but common labor has established its slope.

Common labor is used in the *Engineering News-Record* Index as more representative of general construction than the highly skilled trades that predominate on building construction. Common labor, leading the advance in wage rates, has raised the *ENR* general construction cost index above building cost index levels and has anticipated the rise in skilled wages that is now making itself felt in building costs.

The effect of labor on the *ENR* Construction Cost Index is shown in the accompanying chart. Substitution of a local common labor wage trend, that of New York City, shows how the construction cost rise has lagged there in relation to the country at large. This month's sharp rise in common labor, however, closes up much of this gap. Substitution in the *ENR* Construction Cost Index of the skilled labor cost trend for the common labor trend pulls the index down into the zone occupied by strictly building cost indexes.

The most stable period in recent construction cost history is that from 1925 to 1929. The *ENR* 1929 average for the year, 207, accurately represents its average level for this five-year period. Building cost indexes during this period were fairly close to the *ENR* Construction Cost Index. American Appraisal moved in the same trend as the *ENR* index, Turner and Aberthaw trends were slightly downward, the Associated General Contractors index moved slightly upward.

This parallelism has not prevailed since 1933 when the stimulation to common labor wage rises resulting from federal policies of NRA and PWA raised wages in the lower end of the non-union-union span, and the non-union trend moved upward faster than the union trend. Building indexes necessarily move with the skilled trades.

The accompanying tabular comparison shows the increase in costs as measured by five established indexes. Comparing June, 1937 with 1929 average, *ENR* shows a gain of 15 per cent, American Appraisal reports building costs 10 per cent below their 1929 average, AGC is 5½ per cent below while Turner and Aberthaw show 5 and 6 per cent gains respectively. The gain from June 1936 to June 1937 ranges from AGC at 8 per cent to Turner at 17 per cent, *ENR* 16½ per cent. From January to June 1937 building indexes show stronger relative gains than the *ENR* trend, Turner, 9 per cent, American Appraisal, 8 per cent, *ENR* 7 per cent.

A major reason for the variation between general construction and building costs is shown in the corresponding comparison of skilled and common labor averages. Common labor in June was 18 per cent above 1929 average, skilled labor 2½ per cent below. From June, 1936 to June, 1937 common labor rates increased 22 per cent, skilled 13 per cent. However, this diversion of trend ceased from January 1937 to June, 1937 when common labor rates rose 6½ per cent; skilled, 6½ per cent.

This parallel movement of labor rates is reflected in the return of trends in the building construction cost indexes more comparable to the general construction cost index.

COMPARISON OF CONSTRUCTION WITH BUILDING COST TRENDS.

INDEX	Index Values: Aver. 1929	June 1936	Jan. 1937	June 1937	Percent of Increase: 1929 to Jun. '37	Jun. '36 to Jan. '37	Jun. '36 to Jun. '37	Jan. '37 to Jun. '37
Engineering News-Record	207.02	204.60	223.45	238.15	15	9	16½	7
American Appraisal Co.	204	162	171	184	10*	6	14	8
Aberthaw Co.	189	182.5	195	201	6	7	10	3
Turner Construction Co.	185	167	179	195	5	7	17	9
Associated General Contractors	203	178	181	192	5½*	2	8	6
ENR 20-Cities Average								
Common Labor	$0.547	$0.527	$0.603	$0.644	18	14	22	6½
Skilled Labor	$1.360	$1.074	$1.240	$1.327	2½*	12.3	13.2	6½

* Decrease.

ENR INDEX NUMBERS

COST Base = 100	1913	1926	VOLUME	1913	1926
Sept., 1937	243.95	117.27	Aug., 1937	150	66
Aug., 1937	242.95	116.78	July, 1937	185	81
Sept., 1936	208.10	100.03	Aug., 1936	199	87
1936 (Av.)	206.46	99.24	1936 (Av.)	185	81
1935 (Av.)	195.22	93.84	1935 (Av.)	135	58
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50

THIS WEEK'S FIGURES

(Thousands of Dollars)

CONTRACTS

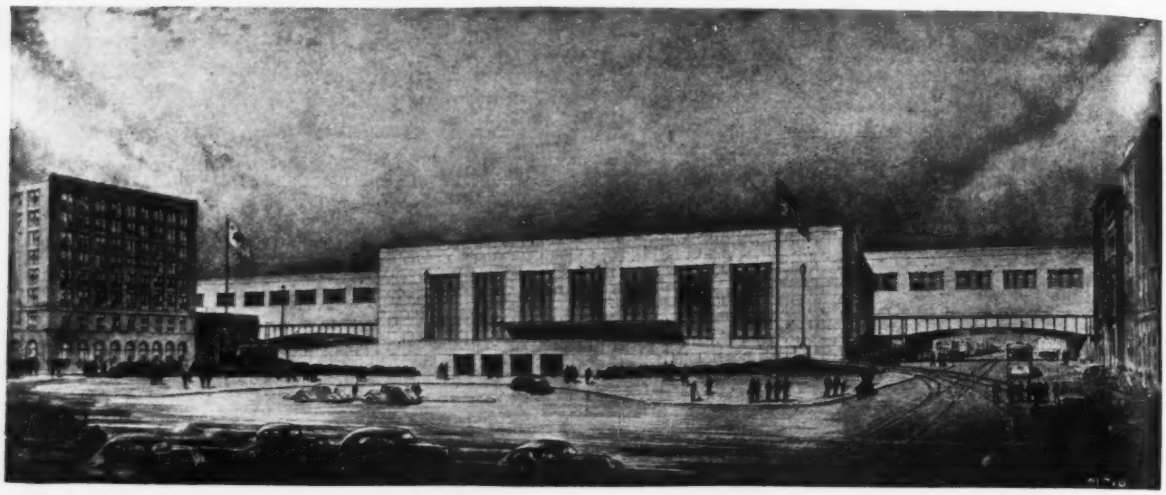
	Week Ending Sept. 3 1936	Aug. 26 1937	Sept. 2 1937
Federal	$4,135	$3,510	$8,535
State & Municipal	24,343	16,752	20,776
Total public	$28,478	$20,262	$29,311
Total private	9,252	17,076	12,314
TOTALS	$37,730	$37,338	$41,625

Cumulative
1937 (35 weeks) $1,717,122
1936 (36 weeks) $1,578,017

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1936 36 Wks.	1937 35 Wks.
NON-FEDERAL	$614,209	$1,174,107
State & mun. bonds	349,313	378,839
Corporate securities	198,877	409,490
PWA loans and grants	55,205	155,839
RFC loans	10,814	29,939
Fed. aid for highways	.....	200,000
FEDERAL	$691,237	$261,057
TOTAL CAPITAL	$1,305,446	$1,435,164



PROPOSED TERMINAL FOR BAY BRIDGE TRAINS

ARCHITECT'S drawing of the San Francisco Oakland Bay Bridge Railway terminal which will be erected in San Francisco between First and Fremont Streets, facing Mission. The edifice is a three story and basement building, 900 ft. long, including the train sheds and the headhouse, or terminal building proper. It will house a garage in its basement and will have concession spaces and a waiting room.

Four doors on the ground floor have been planned to expedite the exit and entrance of commuters leaving on foot. Persons leaving or entering the terminal by trolley will have to walk along only a short graded ramp to connect with the electric trains. Three tracks will be provided for trolleys, which will approach the terminal on an elevated platform. The bridge trains loop into the terminal from the bridge over six tracks which are inclosed within the structure.

Works Department Not Approved

(*Continued from page 369*)

they are to represent a permanent activity, to the proposed new department of social welfare.

Formulation of a public works program for purposes of economic stabilization should be the responsibility of a central planning agency.

Transfer of the control now exercised by the War Department, through the Corps of Engineers, over river and harbor improvements to another federal agency is recommended in the Brookings report. It is suggested that these duties might be assigned to a new Department of Transportation, or alternatively to a Division of Transportation in the Commerce Department, which would also assume functions now scattered among other departments relating to transportation by air, land and water, except purely regulatory activities which would be concentrated in an expanded Interstate Commerce Commission.

As a possible variation, it is suggested that, since the problems of river utilization other than navigation should not be handled by a transportation agency, it might be feasible to create a separate engineering organization to undertake the building and operation of multi-purpose river-improvement structures, as distinguished from lake and coastal projects for the benefit of navigation only, subject to the right of the transportation agency to regulate the use of whatever navigation facilities may be provided. This would logically fit into the same department as the Reclamation Bureau.

"The transfer of river and harbor work to a civilian engineering organization," states the report, "is suggested because it appears to be undesirable for a military organization to be made responsible for unrelated military activities. River and harbor work was originally entrusted to the War Department because the Army possessed the only considerable body of trained engineers in the country. This condition has long since disappeared, and the retaining of civilian functions by the Corps of Engineers is not justified on the grounds of national defense and the apparent economy of using the service of Army engineers in peacetime.

"The economy is at best superficial. For a number of years the officer personnel of the Corps of Engineers has been in excess of its peacetime quota, since it has to be determined by the needs of river and harbor work rather than by strictly military requirements. Furthermore, the fact that the higher posts in the service are invariably filled by military engineers is hardly calculated to encourage the best civilian engineers to remain in the service, although the civilians outnumber the military personnel by ten to one. While it is unquestionably desirable to have supernumerary engineer officers assigned to civilian duties in peacetime, it appears that this service could be served by detailing such officers to work with a civilian organization, rather than by diverting the major part of the energies of the Corps of Engineers to non-military activities."

" . . . An additional objection . . . lies in the present military practice of rotating assignments. . . . No engineer officer ordinarily remains on a given station longer than four years, so that on river and harbor projects there is likely to be a periodic loss of efficiency . . . "

Central planning agencies

Two central planning agencies for public works are recommended in the report, a water planning agency and an agency to plan recovery work. The report points out that one type of water control often conflicts with another, as, for instance, power development and flood control. It finds then "that it might be desirable to establish a review and control agency to formulate policies for the best use of the water resources of each drainage basin. Such an agency should be free from administrative responsibilities connected with construction or operation. . . . It should be an independent unit to advise the Executive and Con-

gress on major questions of policy.

"Basic hydrologic data should continue to be collected by agencies that are independent of the units engaged in construction and development . . . The basic data should be collected by units that are in no way subordinate to promoting agencies in order that no question may be raised regarding the impartiality of the information."

Pointing out that it is frequently argued in favor of a public works department that such an organization could be used to formulate public works programs for periods of depressions, the report states that "The planning of construction needs either for the normal requirements of the government or for emergency purposes and the purely technical job of performing or supervising the actual construction work" are two separate functions. Coordination of routine public construction to meet administrative needs could be effected, the Institute believes, by the Bureau of the Budget. However, "The formulation of long term construction programs, to serve as a method of economic stabilization, should be vested in a central planning agency, either the National Resources Committee or some similar organization." The report suggests that the Public Works Administration might be retained as an administrative agency to supervise the allocation of funds.

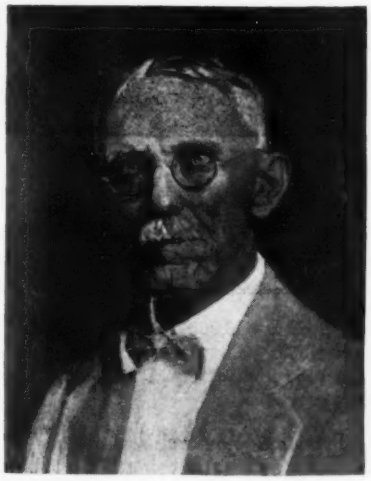
Other construction agencies

The Bureau of Public Roads, the report finds, has the primary objective of providing transportation facilities and it should be classified as a federal transportation agency.

The activities of the Tennessee Valley Authority cut across a number of government functions but are related parts of an integrated program for the development of the Tennessee Valley. The report therefore recommends that the authority be retained as an independent agency engaged in a specialized task. If it were desired to place it under a department of the government, it should be grouped with other river improvement activities.

The objective of the work of the Bureau of Reclamation is land utilization, so that "The proper place for the Bureau is in either the Department of the Interior, the Department of Agriculture, or a new department of land use." It is recommended that the bureau's present practice of acting as a service agency for other government organizations with similar engineering problems should be continued; and while the actual management of Indian irrigation projects should be under the Office of Indian Affairs, technical advice and supervision should be supplied by the Bureau of Reclamation.

The Brookings Institution was engaged by the Senate and House committees on reorganization early this year to study and report on the entire executive set-up of the federal government. Its report has been published in sections, dealing, respectively, with (1) Government expansion generally; (2) federal lending and banking agencies and credit supervision; (3) supply and property; (4) mineral resources and power; (5) financial administration; (6) law enforcement; (7) personnel; (8) public welfare; (9) business promotion; (10) business regulation; (11) land use; (12) transportation; (13) libraries and publicity; (14) public works.



Railroad Engineer Dies

Hunter McDonald, who resigned in 1931 after 39 years' service as chief engineer of the Nashville, Chattanooga & St. Louis R. R. and 52 years of service with the company, died Aug. 24 in Nashville at the age of 77.

After a year at Washington and Lee University, Mr. McDonald began his railroad work with a survey party of the Louisville & Nashville R. R., and in a few months he went to the Nashville, Chattanooga & St. Louis as assistant engineer. Ten years later he became division superintendent of the Huntsville division and in 1891 he became resident engineer of the Western & Atlantic R. R., a leased line. The following year Mr. McDonald became chief engineer of the Nashville, Chattanooga & St. Louis.

Mr. McDonald was president of the American Society of Civil Engineers in 1914. He assisted in organizing the Engineering Association of the South and in 1895 was its president. He was the eleventh member of the American Railway Engineering and Maintenance of Way Association, was a director from the start, and was chosen president in 1904. In 1931 he became an honorary member of the association.

Concrete Pontoon Bridge Planned

Unique structure at Seattle would cost $1,506,000 and be 8,000 ft. long

Plans have been announced for a proposed $1,500,000 concrete pontoon bridge across Lake Washington between Seattle and Mercer Island by Washington State highway director Murrow. If the plans are adopted, the bridge will be the only one of its type in the world, although there are three large steel pontoon bridges, the Golden Horn bridge at Constantinople, the Coblentz bridge over the Rhine in Germany, and the Erie Lagure bridge in French West Africa.

It had previously been proposed to build a $3,400,000 bridge of more conventional design between Seward Park in Seattle and the south end of Mercer Island. The site for the proposed pontoon bridge is farther north, from Faber Point on the island to Dearborn Ave. in Seattle, a distance of 8,000 ft.

Consultants appointed

A board of consulting engineers, headed by C. E. Andrew, designer and builder of the San Francisco Bay bridge, will check designs and location of the bridge. Other members of the consulting board are R. B. McMinn of the U. S. Bureau of Public Roads and R. H. Thomson, Seattle consulting engineer.

Description of bridge

The bridge will consist of a series of concrete pontoons, fastened together and anchored to a sunken island at a point where the water is only 36 ft. deep. It would carry four traffic lanes and two sidewalks.

A movable span to permit large boats to pass through is also under consideration, although not included in the estimated cost. Plans are being considered for either a bascule structure or a swing bridge operated by propellers. A 1200-ft. tunnel may be built at the Seattle approach to the bridge.

The bridge would be built by the State Toll Bridge Authority. An application for $1,750,000 to help finance construction of a bridge at the Seward Park site has been pending with the PWA for several years. This application would be revised to fit expenditures for the pontoon bridge. Sale of bonds to be retired by tolls is proposed in order to raise the remainder of the money.

Approval of the War Department is necessary before the bridge can be constructed.

WASHINGTON HIGHLIGHTS

Special reports by Paul Wooton

POWER shortage in the northwest makes prompt negotiation of contracts at Bonneville desirable. Negotiation of these contracts will be difficult. Private power companies are not greatly interested because the contract is limited to twenty years. Preferences are given to public agencies. If they are awarded contracts construction of transmission facilities may be involved. The matter is complicated further by the fact that blocks of power must be reserved for the future use of public agencies.

As power will become available Dec. 1 little time remains to arrange for its utilization. As this is written the administrator, who will negotiate the contracts, has not been named.

When the administrator of the Bonneville power project is named he will have to ask the Commissioner of Reclamation for the money he will need. Despite the fact that there was no suggestion at any time that the administration of the project be vested in the Bureau of Reclamation, Congress nevertheless voted the Bureau an additional $100,000 for administration expenses at Bonneville.

A considerable amount of red tape is involved in the transfer of an appropriation from one agency to another. Delay frequently results, as the Comptroller General usually makes a detailed study before he will approve such a transaction.

Witnesses appearing before the Board of Engineers for Rivers and Harbors in behalf of the immediate installation of power generating equipment at the Fort Peck dam were unable to present concrete evidence that there would be a market for the power. The district engineer recommends that installation be deferred until a market can be developed. In view of the power shortage in the Northwest the Board of Engineers is expected to recommend an appropriation that will permit at least one of the 35,000 kw. units to be installed despite lack of a definite market. It is believed that some one of various possible uses will develop. The other two units can be installed when the need is more clearly defined.

Failure of the bill authorizing the creation of the position of administrator at the Fort Peck project was due to the belief that the proposed operation was not large enough to justify the employment of a $10,000 administrator. The bill which passed the Senate provides for a position of equal rank with that at Bonneville.

President Roosevelt on August 27 signed the Army Housing Bill authorizing the rehabilitation and construction of facilities aggregating $25,587,456 at various military posts in the United States and territories.

A bill giving the State of Maryland permission to construct bridges across Chesapeake Bay and the Patapsco River was vetoed by President Roosevelt on August 27. The action was based upon War Department protests.

A LONG WAY FROM THE BOTTOM

TRASHRACK *structures* for Parker Dam, high up on the California canyon wall at the entrance to the power pen stocks, are a long ways above the 130 ft. pit where concrete is now being placed on bed rock for the foundations.

Concreting Record Set At Grand Coulee

A world's record for concrete placement was set at Grand Coulee during the week ending Aug. 28, when the contractors placed 101,738 cu.yd. of concrete in the dam. On Aug. 24 the 24-hr. pour was 15,534 cu.yd. of concrete.

Grand Coulee dam is now the largest mass of concrete in the world, concreting operations having passed the 3,250,000 cu.yd. total established for Boulder dam. When the dam is finished, it will contain about 11,250,000 cu.yd. of concrete, more than three times the amount in the Colorado River dam.

TVA Signs Standby Pact With Power Company

The Tennessee Valley Authority has approved a contract with the Tennessee Electric Power Co. providing for system interconnection and for mutual emergency standby service, thus eliminating immediate necessity for construction of an additional $1,000,000 transmission line from Wilson Dam to Columbia, Tenn. Under the terms of contracts for the sale of surplus power with the Monsanto Chemical Co. at Columbia and the Victor Chemical Works at Mount Pleasant, the TVA is obligated to provide standby service and, if this contract had not been arranged, would have had to build a transmission line to provide such service. A TVA transmission line now runs from the authority's Wheeler dam to Columbia.

From the contract, the Tennessee Electric Power Co. gains protection for service out of its Centerville substation, including service to the city of Nashville.

No outright sale of power is provided for in the contract, but the company and the authority will aid each other in case of emergency on either system. The interconnection will be made through construction by the company of a 154,000 volt transmission line from its Centerville substation to the TVA substation at Columbia. The authority will pay the company a rental of $1,000 per month for the use of this line.

Gate Bridge Reduces Truck Tolls

Action follows sharp drop in traffic when ferries reduce passenger car fares

Truck tolls were reduced to a flat rate of 50 cents Aug. 26 on the Golden Gate bridge. This fare will apply to any truck, loaded or unloaded and regardless of weight; an additional 50 cents is charged for detached trailer, loaded or unloaded.

The action of the bridge directors followed a severe drop in traffic which came as a result of the lowering of passenger car fares from 50 to 30 cents by the ferries across the bay (*ENR*, Aug. 19, 1937 p. 292). Traffic on the bridge during the week of Aug. 15-22 dropped to 75,580 vehicles, as compared with traffic of 98,742 vehicles the week of Aug. 1-8. Traffic has also dropped on the San Francisco-Oakland Bay bridge, but no action has been taken on fares.

The bridge district has appealed to the California Railroad Commission for a rehearing of its order authorizing the ferries to reduce their passenger car rates. The district contends that the commission exceeded its jurisdiction in stating that a standby service was needed and that traffic might therefore be taken from the bridge and given to the ferries. The appeal is also based on the fact that the railroad commission's order was based on an estimated reduction in bridge traffic of about 5 per cent, whereas traffic dropped 12 per cent from normal during the first week after the reduction and 20 per cent the second week, with further reductions expected.

The bridge directors have also voted that the finance committee consider a proposal to reduce the existing passenger car toll.

• • •

Special Sessions Are Urged For New England Pacts

President Roosevelt has urged that Connecticut, Massachusetts, New Hampshire and Vermont call special sessions of their legislatures to approve a new interstate flood control compact which will meet the objections raised in Congress to the compact already drawn up and permit immediate start of work on flood control on the Merrimack and Connecticut Rivers.

The existing compact was thrown out by Congress because of provisions reserving to the states all rights to power which might be generated on the rivers. The President in a letter to Representative Citron of Connecticut suggested that "the failure of Congress to consent to the compact should not mean that the project must wait until Congress again meets to take further action. The flood control act of 1936 gave advance consent to compacts which provide only for the manner of making the contribution . . . and the proportion of such contribution to be made by each state.

"Flood control in these basins is of sufficient importance . . . to warrant the calling of a special session of the legislatures to approve a compact.

"As soon as such a compact is agreed to . . . the Secretary of War would be able promptly to commence construction of the projects."

• • •

Seavey Represents Nation In Yellowstone Parley

Clyde L. Seavey, vice chairman of the Federal Power Commission, has been appointed by President Roosevelt to represent the government in the Montana-Wyoming negotiations for division of Yellowstone River water.

The commission to which Commissioner Seavey has been appointed was authorized by a resolution of the last Congress to negotiate a compact providing for an equitable division and apportionment between the states of the water supply of the Yellowstone River and its tributaries and to report such compacts to the Congress for approval.

• • •

Joint Committee to Study Ohio Pollution

In signing Aug. 27 the Rivers and Harbors Act of 1937, President Roosevelt announced he intends to ask the Secretaries of War and the Treasury to name a joint committee of three to conduct a pollution survey of the Ohio River.

"Obviously," he asserted, "a survey of this nature as provided in this bill, falls properly under the jurisdiction of the Public Health Service. I am, however, asking the Secretary of War and the Secretary of the Treasury to join in the appointment of a committee of three to conduct this survey. An army engineer, a representative of the Public Health Service and a non-government expert on pollution problems."

The bill, which authorizes 146 projects for improvement of navigation at an aggregate cost of $53,716,525 and directs the preliminary examination of a number of proposed projects, directs the Corps of Engineers to make the pollution survey of the Ohio.

Roof Collapse In Atlanta

Collapse of reconstructed auditorium roof caused by failure of defective steel joists

After a heavy but not unprecedented rainfall Aug. 22, a 1,625-sq. ft. section of the roof of the rebuilt city auditorium in Atlanta collapsed. Reconstruction of the old auditorium, which collapsed a few days before it was to have been dedicated, has been going on for the past three years as a WPA project, at a cost of about $606,000.

At the request of the Georgia branch of the Associated General Contractors, a non-partisan committee of building experts was appointed to determine the cause of the collapse and whether the rest of the auditorium was safe. The committee consisted of Robert S. Fiske to represent WPA, Robert G. Lose to represent the city, and Carl F. Nonnemaker, to represent the public.

The report of the commission found that "accumulation of water on the collapsed portion of the roof was not sufficient to have caused failure of a proper design. . . . The design was according to standard practice.

"Your commission is of the opinion that the cause of the collapse was the failure of the open web steel joist supporting the roof deck. Your commission is of the opinion that the steel joists were of defective manufacture.

"Steel joists of the same type and same manufacture have been used in the construction of the roof of the entire assembly hall."

The commission went on to recommend that the section of the work in which the collapse occurred be redesigned with a pitch to prevent the accumulation of water and that additional outlets be provided. It was further recommended that all steel joists used in other parts of the auditorium which were of the same manufacture as those in the collapsed section be replaced with joists inspected and tested.

Steel for the auditorium was purchased from the Builders Speciality Co. of Atlanta which was the lowest of five bidders, and the joists were manufactured by the Riverside Steel Co. of Wheeling, W. Va.

A statement issued by WPA announced that all the money alloted to the project had been spent and that no funds were available to repair the collapsed work. It was stated, however, that the city was eligible to sponsor a project for the repair of the damaged roof.

News Continued on page 407

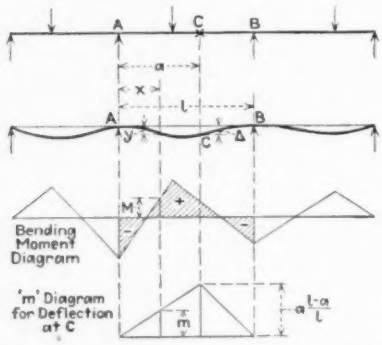
COMMENT AND DISCUSSION

Readers' opinions on matters that concern the engineer

Beam Deflection

Sir: Daniel C. Drucker, in his letter appearing in your issue of August 12, page 252, writes: "To find the deflection of a beam at any point even for the case of simple spans is often not an easy matter, and for a continuous beam becomes very much more difficult if fundamental methods are used without simplification."

The writer would point out that once the bending moments are known, the deflection of any span *A B* of a continuous beam can be obtained by considering the span as a simple span, subjected to the continuous beam moments.



Determining deflections of continuous beams.

If the method of successive integration is used, the fundamental equation is $E\,I\,d^2y/dx^2 = -M$; the constants of integration are determined by the condition that $y = O$ at both supports, and by the condition that y and dy/dx do not change abruptly at points where the equation for M changes. Except for the equation for M, the procedure is the same as for a simple span.

If the formula derived from the method of elastic energy is used, "m" in the equation $E\,I\,\Delta = \int_A^B M\,m\,dx$ is the bending moment from a unit load applied to the equivalent *simple span* at the point *C* whose deflection is sought, while M is the actual bending moment in the *continuous span*.

If the method of "elastic weights" is used, $E\,I\,y$ is the *simple-span* bending moment obtained by loading the span with the area of its *continuous-span* moment diagram (shaded in the figure), giving due regard to the sign of the moment.

This method can be used for any span that rests at both ends on unyielding supports, whether the beam is restrained or hinged at either or both supports. The correctness of the method is evident from the consideration that the curvature of a given beam depends only on the bending moments to which it is subjected, regardless of the conditions of loading or support that produce those bending moments.

Pittsburgh, Pa. HENRY W. TROELSCH
August 18, 1937.

Waterworks Management

Sir: The articles on waterworks management and organization by E. G. Plowman (ENR Aug. 5, 12, 19) cover a vast amount of territory and present a careful "diagnosis."

In my opinion the very best way to acquire knowledge relating to organization and management of waterworks systems is to visit other water plants as Mr. Plowman evidently has done. I believe if waterworks executives had the privilege of making inspection trips of this kind, it would more than pay for the expense involved.

In lieu of acquiring information in this way, published articles like Mr. Plowman's are most instructive and timely for they bring to waterworks executives' attention the fact that there is room for much improvement both in operation set-ups and charter provisions.

Public should be informed

Not only should waterworks executives be informed of these facts but citizens generally should also be cognizant of improved methods, as the impetus for action in amending city charters and accomplishing improvements in management must come from public groups of citizens. Publication of that portion of city charters having to do with the organization of well-managed waterworks would, I believe, be of assistance to officials in acquiring information for a better operation and management procedure.

ENGINEERING NEWS-RECORD is to be congratulated on its aggressiveness in publishing articles of special interest to waterworks managers.

Denver, Colo. GEO. F. HUGHES
Executive Secretary,
Board of Water Commissioners

Better Water Service

Sir: Mr. Plowman's articles (*ENR* Aug. 5, 12, 19) indicate a thorough understanding of conditions in the waterworks field and his analysis of organization defects in the handling of water utilities in many cities and towns is timely and to the point.

The development of a water supply and its delivery to the consumers is an important factor in the life of any community. The health of the people is dependent on a safe and adequate supply and a careful program must be in operation at all times to maintain this condition. The management of such a utility is not materially different from that of any other similar business. If the organization is not properly centralized the proper efficiency cannot be established nor best results obtained.

Public or private

There is no reason why, with proper basic organization and capable management, the publicly-owned water utility should not be operated equally as well or better than a privately-owned utility. The secret of any such organization is that the authority be centered in one governing body and that the men selected on the board of directors should be public spirited individuals who take their offices, with little or no pay, entirely as a public service for their home community. As long as the water department is made a political football, no efficiency can result and no proper personnel relations can be developed.

The East Bay Municipal Utility District, which serves some 510,000 inhabitants in Oakland, Berkeley, and seven other California cities, has been particularly fortunate in electing as directors men who are interested only in promoting efficiency in

the organization and in bringing the best possible water service to the consumers served. The board consists of five members, one from each of five wards but all elected at large. Since the formation of the District in 1923 there have been eleven members of the board. At present one of the members has served 14 years, one 13 years, one 9 years, one 4 years, and one 1 year. The directors receive $10 per meeting with a maximum allowance of $20 per month. The president of the board—former governor of California George C. Pardee—has served with distinction in that position for 13 years. Under the guidance of this board, the operations of the district have been free from political interference and have been handled in the same manner as would be expected in the case of a private corporation.

The continuance, in some communities of the present efficient system—properly centralized and free of politics—and the reorganization and removal of politics from many other water utilities, is a field in which a great deal can be done and I think Mr. Plowman's suggestion that waterworks associations give this matter consideration and take definite action in support of independent and well managed water utilities should receive the support of all water utility executives and personnel.

Oakland, Calif. J. S. LONGWELL
Chief Eng. and Gen'l Mgr.
East Bay Municipal Utility District

"Seems Almost Too Obvious"

Sir: I read with considerable interest in your issue of Aug. 19 the letter of Raymond Wagner of Rockford, Ill., "No Need for Unions." Mr. Wagner's reasoning is the most sound and sensible of any of the recent series of discussions on the subject.

In my eighteen years of experience I have been urged many times to join unions and have consistently refused because I felt that they could not solve the salary problems of professional men, and this seems almost too obvious to admit argument. I believe, as Mr. Wagner states, that the income of engineers is too low because their average worth is too low. We all know of engineers of recognized outstanding ability whose incomes though not fabulous have been quite satisfactory.

It has been my observation, too, that the profession is burdened with a great many "mediocre and downright bad engineers," using Mr. Wagner's words again. The elimination of these would do more to raise the incomes of engineers, and do it on a more lasting basis, than the efforts of any union, granting that the intentions of the unions are always for the best interests of their members. Then too, isn't there much more satisfaction in advancement on the basis of merit and efficient service rendered than merely to advance in income because a union brings pressure to bear on one's employer?

The elimination of unqualified engineers can, I believe, best be done by the right kind of license laws, the kind that will include employed engineers as well as practicing engineers, above a certain grade. The different grades could be worked out on a basis similar to that of the U. S. Civil Service Commission. I feel quite sure that employers of engineers in general would be willing to pay more for the services of engineers classified on some such basis. I know that effort is being made by some engineering societies to promote licensing provisions similar to what I have outlined and I firmly believe this is the soundest method of advancing incomes for those whose ability stamps them as real engineers.

Charleston, S. C., Aug. 25, 1937 CARSON G. JENNINGS
Associate Structl. Engr., Charleston Navy Yard

Unionization

Sir: I have been instructed by the Executive Board of our local chapter to protest the editorial policy of the *Engineering News-Record* in connection with the attacks on progressive trade unionism for technical professionals.

The continuation of this thoroly outdated and Bourbon policy will, we can assure you, carry with it the most effective boycott of your magazine in this industrial area that you have ever had reason to experience.

Philadelphia, Pa.
Aug. 21, 1937 H. MOWRY
Acting Sec. Phila. Chap. Federation of Architects, Engineers, Chemists and Technicians

Good Reason to Organize

Sir: In the *Engineering News-Record* of Aug. 19, 1937, Raymond Wagner says, "What we do not need are trade unions. We have no quarrel with unions for tradesmen but we are not tradesmen. Perhaps if a man intended to sit at a drafting table doing one type of work all his life, or if a man were to be a rodman or transitman until he died, a union would be entirely proper. But such a man is not an engineer."

I have been engaged in engineering for almost forty years, and during that time I was resident engineer on a trunk line railroad, being in responsible charge of 35 mi. of very difficult grade reduction. My salary was $83.33 per month. At that time, the company paid the passenger brakemen $100 per month. A year or two later I was chief engineer of a very prosperous and busy short line railroad, and the most I ever received from that road in ten years' service was $125 per month, although I had trade union men working for me and under my jurisdiction who received almost twice as much as I did. The consequence was I quit the railroad service and started freelance.

If engineers working on salaries are not organized, call it trade union or what you will, they will never be overpaid; that much is certain.

Now as to Mr. Wagner's statement concerning a lifetime at the drafting table. I do wish that young engineers would stay at a drafting table long enough to quit dotting capital I's, using apostrophes where they do not belong, and misspelling the simplest words. I also wish that a rodman or transitman would stay long enough at that work to know enough to hold a rod vertically and read an angle accurately.

I think we exalt the name "Engineer" entirely too much. What is an engineer? Nothing but a man who is expert at his trade, whatever it may be. There is nothing sacrosanct about an engineer any more than there is about a preacher. As a class, we engineers take ourselves too seriously.

The *Engineering News-Record* is certainly to be congratulated in its new dress and splendid reading matter. It has been a weekly visitor in our office for thirty-seven years.

Beardstown, Ill., August 25, 1937 ALLAN D. MILLARD
Goodell and Millard Civil Engineers

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COINCIDENT WITH FIELDWORK on the preliminaries of converting the remnants of the South Penn railway into an express highway, a thousand miles to the south the conversion of the Key West line to highway use is nearing completion. Twenty-five years ago the Key West extension was a wonder of railway enterprise, as was the South Penn venture a quarter-century before that. Today these lines are prominent illustrations of the widespread readjustment that is going on in the transportation field. The railway is settling down to its basic job of long-distance main-line haulage, where its efficiency is unrivaled, and the unnecessary feeder and competitive lines of empire-building days are going into the scrap pile as the highway takes up its part of the job. Rational stabilization of railway-highway relations thus is in sight—fortunately. If the relative positions of waterway and railway were as well defined, public and private pocketbooks would be the gainer. But in the absence of waterway cost-accounting that would establish the basis for such a definition, continuing expenditures of millions of dollars on waterways threaten large losses of public funds and unsettle many private investments dependent on transportation.

Bridge and Ferry

FERRIES AND TOLL BRIDGES are in competition at San Francisco. The State Railroad Commission believes that the ferries should be encouraged to continue, since they might be needed if accident or calamity prevented use of the bridges. Therefore the ferries are to be permitted to try out a fare lower than bridge tolls. At the Commission's hearing, lowering ferry tolls was opposed by the California Toll Bridge Authority. The decision in effect denies the validity of the Authority's views. On the other hand it forecasts the end of the ferries "for economical reasons, upon the first substantial toll reduction made by the bridges." While reduction of bridge tolls to kill off ferry competition would be obviously immoral, it may be expected that if the decreased ferry rates do not attract the additional traffic hoped for, so that the ferry losses of recent months continue, bridge income may be swelled automatically by the traffic accruing through discontinuance of ferry service. Toll reduction then would be logical. Such an outcome, however, would not prove whether or not the ferries have a necessary place in trans-bay transportation; establishment of a toll differential, as now, is better adapted to answering this question.

Height of Folly

LATEST LABOR NEWS reports the action of several American Federation of Labor unions in refusing to handle products of industrial plants organized by the Committee for Industrial Organization. Such action is as vicious and unwarranted as jurisdictional disputes, for the cause is wholly one of inter-labor strife, and the owner and public are innocent victims. Lumber and electrical products are among the articles affected; both are important construction materials. Is a contractor using A. F. L. labor supposed to check the source of his materials to determine what labor organization produced them? Is he to boycott a manufacturer who, because he complied with a law which the A. F. L. helped push through, is required to use C. I. O. labor? We think not, and we regard the latest stand of the Federation as the height of folly. The public has rights which it will not permit to be trampled on. Labor will gain nothing and will lose much if it insists upon such foolish action.

Greater Responsibility

THE SOCIAL IMPLICATIONS of engineering progress and the responsibility placed on engineers by the social changes wrought by their work were the subject of comment before two diverse groups in recent weeks. At Montreal the late Harrison P. Eddy, in a paper for the semicentennial of the Engineering Institute of Canada written a few days before his death, left with the profession the warning that unless it will undertake to assist the community in making good use of the extra leisure given by the work of the engineer the profession will not be living up to its full responsibility. Similarly at Cambridge Prof. Thomas N. Whitehead, speaking to a meeting of engineering educators, said: "Unless we can train up engineers whose interest in vital social processes is comparable to their technical interests, I fear that we may be paving the way for a companion volume to Gibbon's Decline and Fall of the Roman Empire." These warnings are timely as the nation moves forward into another period of great engineering activity, a period that may bring still more leisure time in its train. But responsibility for the necessary adjustments rests on the whole community.

The engineer's part is to anticipate the effect of invention and mechanical development on the processes of production, to the extent of being able to advise the sociologists as to the implications of technical progress.

Endurance in Structures

BRILLIANT experimental research into the phenomenon of endurance of metals carried on during the past two decades has brought about the complete modernization of early views of the endurance of structures under repeated or alternating stress. Further active experimentation continues to add to endurance knowledge. Enough progress has been made to define the structural engineer's relation to fatigue and endurance.

Long ago the work of the investigators overthrew the early concept that the metal of a bridge is weakened by alternating or repetitive stress, as was assumed by the old Launhardt method of proportioning bridge members. Nothing in the behavior of steel within normal working limits gave support to the requirement of excess section imposed by such formulas. It is now recognized that the survival of these formulas in the form of specification rules is an anachronism so far as fatigue action is concerned.

Against this, however, the modern researches have shown that local stress concentrations are of serious importance. Whether arising from defects in the material or from holes, reentrant angles or abrupt changes in section, points of stress concentration constitute weak spots, in some measure even in highly ductile material. This finding acquires special weight for bridge and structural steels in proportion as practice trends away from the soft steel of earlier days and toward stronger and harder steels. In hard steel the concentration of stress at local irregularities—which may carry the stresses up to the yield point even at or below working load—not only lowers the endurance of the structure, but also reduces the margin of safety under static loading.

The danger that lies in lowered endurance is seen most clearly in the light of modern understanding of the part played by vibration in the stress history of bridges, as well as of many types of building. Stress repetitions running to many millions may be experienced by a structure during a relatively short period of service, and if high stress concentrations are present the risk of "fatigue" damage, or in simpler terms the formation of a spreading crack, is imminent.

Fortunately the remedy for this condition is simple. It is often sufficient to shape details more carefully, so as to reduce if not eliminate stress concentration, although this will not affect stress-raising due to surface factors and internal discontinuities. It should be borne in mind that mere increase of section is often useless and at times may aggravate the fatigue hazard, since abrupt transitions in rigidity of parts are a prime source of stress concentration under dynamic load.

To increase the section of main members as a means of endowing a structure with endurance strength is quite ineffective, since the main members are not exposed to fatigue effects. Rules that aim to provide surplus strength in details and connections of such members may be useful if skilfully applied, but in any event they are a less direct path to the desired result than such shaping of the details as will remove the worst sources of local excessive stress. Proper form of the details will guard against both static and dynamic excess; avoidance of abrupt changes in rigidity will prevent dynamic excess. Intelligent application of the teachings of modern endurance research thus is as pertinent to structures as to machines.

Flood Control Set Back

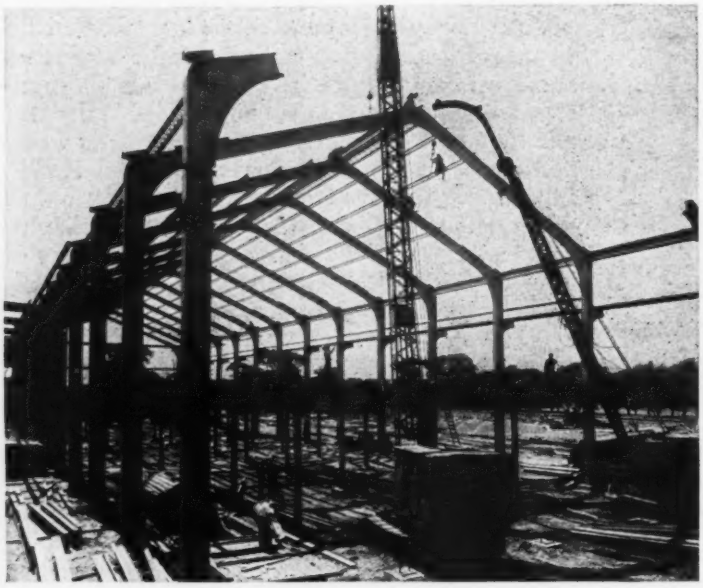
THE FAILURE OF CONGRESS to ratify the New England interstate compacts does serious injury to the cause of flood control. Drafted on the urgent plea of emissaries of the President, the compacts were written to meet the terms of Congress' own flood-control act. When Congress did not ratify them it cast doubt on its own sincerity and rendered the states powerless to begin on their part of the work.

Experience proves that the determination to combat flood hazards, which is strong immediately after a destructive visitation, soon loses its force, and returns only after another great flood. In the light of this condition the setback given to flood-control sentiment in New England by the inaction of Congress jeopardizes the whole plan for safeguarding the Merrimack and Connecticut and their companion streams.

Because these rivers were the first on which the newly adopted policy of federal flood control was to find application, this policy itself is now placed in doubtful position. The President's criticisms of the compacts, which led to the inaction of Congress, indicate that the policy laid down in the 1936 Act may not be carried out unless the states surrender substantial parts of their right of self-government. The states are likely to refuse such surrender.

If federal flood-control aid is to be made a pawn in the game of transferring authority over streams from the states to Washington, Congress should declare itself accordingly. Then the states could proceed to frame compacts for cooperation without federal aid, and could then go forward with flood-control through their own efforts.

PICTURES IN THE NEWS



RIGID FRAME BENTS of 80 ft. span distinguish the all-welded addition to the Lincoln Electric Co. plant in Cleveland. Walls will consist of bands of glass block and sash, and there will be rigid frame saw tooth roofs. Designer and builder is The Austin Co.

DESERT DIGGING leads to an arm chair in Washington. Roy Williams (left), former All-American Canal engineer and new assistant reclamation commissioner, is welcomed by Commissioner John Page.

MODEL of flood gates being built by Westinghouse to protect its Pittsburgh works. Vice president Ralph Kelly watches designer J. E. Webster make some adjustments.

FIRST of 35,000 buckets of concrete that will make Parker Dam goes into a 235 ft. hole in the floor of the Colorado River.

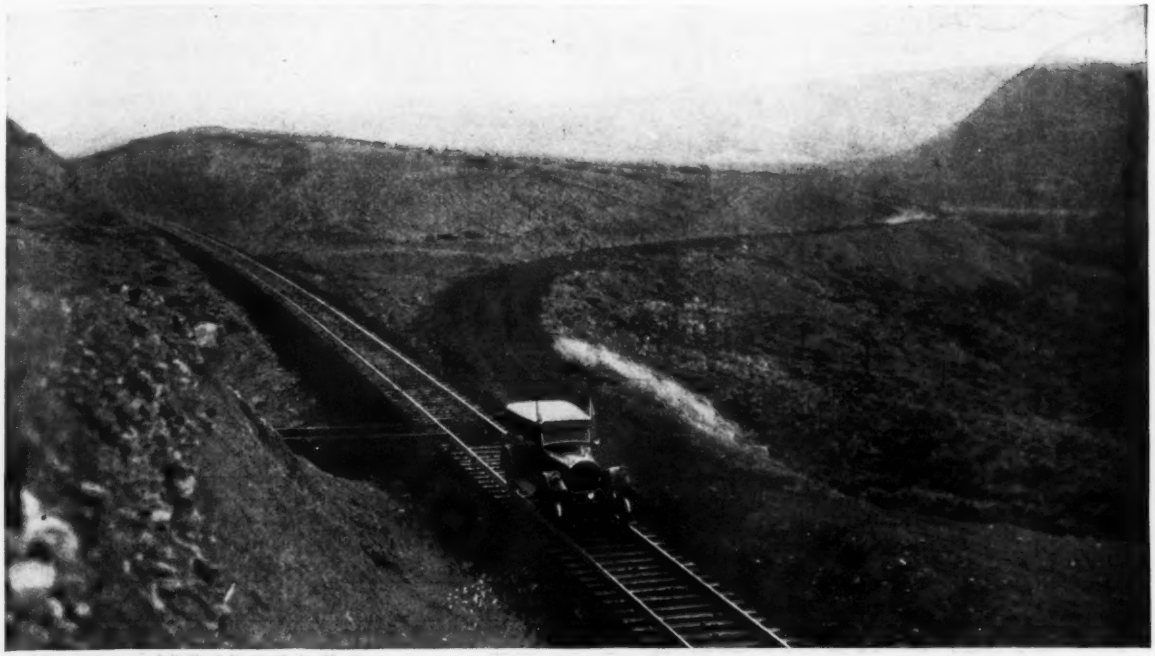


FIG. 1. A MAJOR LINE IMPROVEMENT OF THE REBUILT MOFFAT RAILROAD

Rebuilding the Moffat Railroad

Famous Rocky Mountain route has been transformed from decrepit and bankrupt line into first-class profitable property by complete rehabilitation program

A LITTLE MORE than a decade ago the Denver & Salt Lake (Moffat) Ry., stretching from Denver 255 miles northwest across the high Rockies of Colorado, was a decrepit, bankrupt property that hardly could be called a railroad. Stalwart Dave Moffat's ambitious short cut from Denver to Salt Lake—which never reached more than half-way to its goal and ended in the Yampa Valley in northwestern Colorado—was threatened with extinction as high costs and physical difficulties of operation created never-ending deficits and sorely tried the hearts of operating and administrative officers. Maintenance was non-existent, for there were no funds for roadway upkeep. Somehow trains crawled over loose rails resting on rotten ties, eased around 16-deg. curves, poked their way through 55 tunnels whose old timbers had not been touched since installed some 35 years ago, and crept over creaking light timber bridges. Sometimes the neglected track or structure failed and spilled trains into a canyon or down a mountainside. Short sidings of less length than most freight trains and at all-too-infrequent intervals complicated the task of doubling up on steep grades and caused exasperating delays in train meets. Passenger trains had a scheduled running time of 15 m.p.h. and were never on time; freights had no schedule but wormed along from station to station. No wonder that in 1922 when the road was blocked for 90 days by a rock fall in a tunnel there were grave doubts as to whether operation would ever be resumed.

This sorry picture no longer exists, Today the Moffat is a first-class railroad, part of it being a transcontinental route by virtue of the Dotsero cutoff, connecting with the Denver & Rio Grande Western Ry., which shortens the Denver-Salt Lake run by 174 miles. The road now operates through the magnificent Moffat tunnel, which cut out 23 miles of 4-per cent grade above El. 9,100 and eliminated much of the line's operating difficulties. The original track bed, merely roadway grading and built to no consistent gradient, has largely been rebuilt to a compensated grade and ballasted with volcanic cinder ballast that Moffat engineers claim is the equal of any in the world. Creosoted ties now abound where worn-out rotten sleepers formerly existed; new 100-lb. rail is replacing the worn 80-lb. sections laid when the road was built. Two-thirds of the road's old timber bridges have been eliminated through the use of fills and culverts or by stream channel changes.

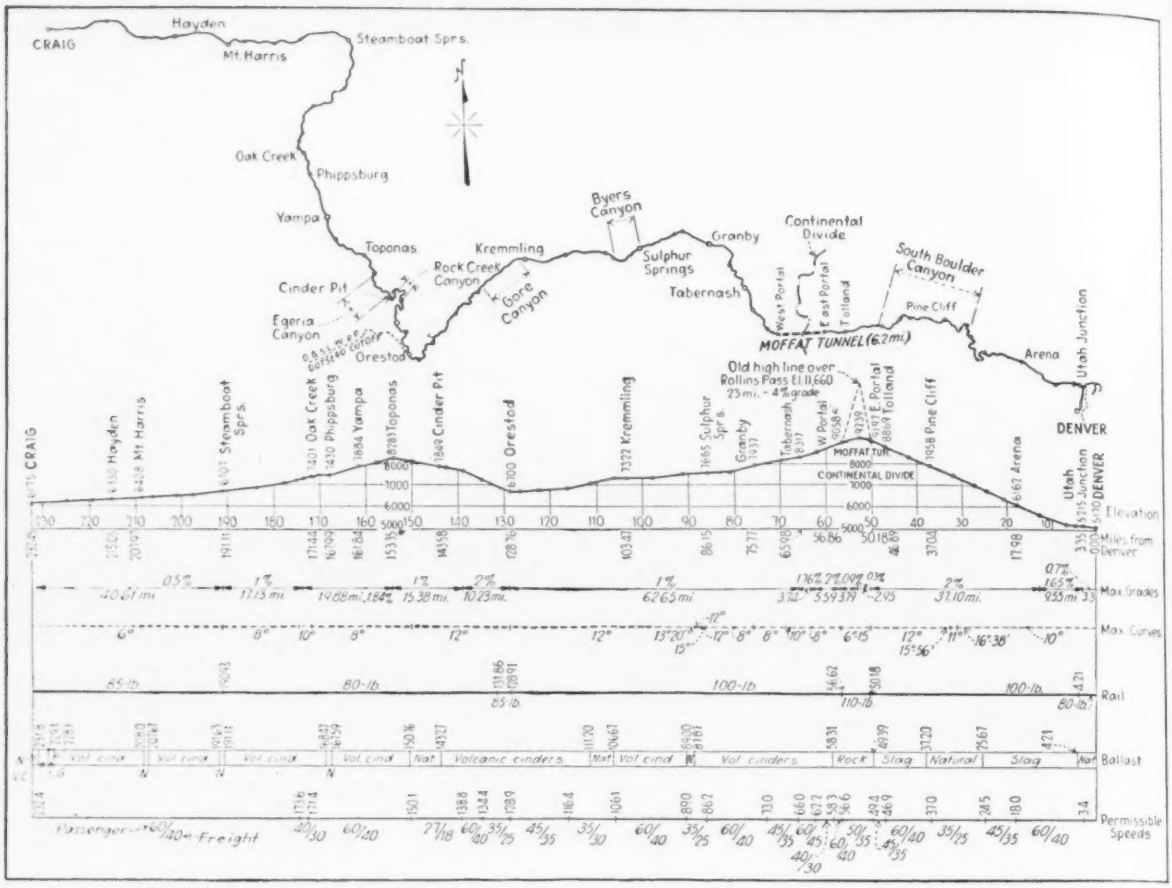


Fig. 2. Map, profile and diagrams of present physical characteristics of the Moffat Ry. Prior to the current improvement program the line was unballasted, train speeds were limited to 20 m.p.h., untreated ties were rotten with age, all rail was 80 lb. and 16-deg. curves were numerous.

Serpentine stretches of track and bad curves, always difficult to maintain and ever a bar to fast operation, have been eliminated by both major and minor line changes. In fact, all but two of the 16-deg. curves have been abolished, and these two and all others of greater radius have been spiraled and superelevated. Speeds of 60 m.p.h. (40 m.p.h. for freights) are now permitted on 140 miles of line, subject to local restrictions for certain curves. The minimum speed restriction is now 27 m.p.h. for the eleven miles through adjacent Rock Creek and Egeria canyons where the topography precludes further reduction in curvature. Elsewhere speeds of 35 to 45 m.p.h. are permissible. Running time has been cut in half and trains easily maintain their schedules. Fig. 2 shows the present characteristics of the line.

Except for the Moffat Tunnel and Dotsero Cutoff, these many improvements are part of an extensive rehabilitation program started by the railroad in a small way in 1926, but pushed vigorously in the past four or five years. The program included replacement of timber lining of the Moffat Tunnel with concrete (*ENR* Dec. 5, 1935, p. 774), completed in January, 1936, and eliminating a $100,000 yearly timber maintenance charge. Rail and tie replacements, ballasting, bridge elimination, line changes and plant betterment have proceeded at a steady pace, carried out economically and resulting in remarkable savings in operating costs. Though the program is not yet complete, maintenance costs already have been reduced 50 per cent.

History of line

To fully appreciate the significance of the rehabilitation work it is necessary to know something of the history of the road. The line was organized as the Denver and Northwestern Pacific Ry. in 1902 by David H. Moffat to provide a direct route from Denver to Salt Lake. Construction started in 1903 at Utah Junction, just outside of Denver. The new line followed rugged South Boulder Canyon to Boulder Park, 46 miles from Denver, requiring 29 tunnels and numerous 16-deg. curves. Moffat had hoped to drive a tunnel under the Continental Divide in the vicinity of the present Moffat Tunnel, but lacked the necessary funds. In desperation he carried the route over bleak Rollins Pass (El. 11,660) on a 4-per cent grade. In 1889, the Burlington had considered a line through this territory and had even started a tunnel under the shoulder of James Peak at Yankee Doodle Lake, which the Moffat high-line almost completely circled. Muck from the abandoned tunnel was used as a roadbed along the lake shore.

In 1904, the Moffat had been built down the western slope as far as Arrow, 75 miles from Denver. Construction of the highline had exhausted the road's funds, and work

was stopped for some time, though in 1905 a 4-mile line was built from Utah Junction into Denver.

In 1907 work was resumed on the main line, and in 1909 rail was laid into Steamboat Springs, 144 miles west of Arrow. The route followed the Colorado River through Fraser, Byers and Gore Canyons to Orestod, then turned up Rock Creek and Egeria Canyons over Toponas Summit into the Yampa River valley.

Fig. 3. Ballast train and gang in Byers Canyon. For the first time since the Moffat Ry. was built 30 years ago the entire line is being ballasted.

Lack of funds once more stopped construction, and Steamboat Springs became the western terminus. Moffat died in New York in March, 1911, while seeking financial help.

The road went into receivership on May 1, 1912, and was reorganized exactly a year later as the Denver & Salt Lake Railroad Co. Funds were made available for another extension to the west, and in 1914 rails reached Craig, 255 miles from Denver, the present western terminus. However, high cost of operation put the line into receivership again, August 17, 1917, where it was to remain until January 1, 1927, when the Denver & Salt Lake Railway was formed.

The Moffat Tunnel, financed by bonds issued by the Moffat Tunnel District, the territory served by the railroad, was started in 1923. It was opened to traffic February 26, 1928. The tunnel cost $18,000,000, three times the estimated cost. Before the tunnel was complete and final expense determined, the railroad signed a 50-year lease with 49-year additional option for its use on a rental basis that will amortize only about half the bonds; the district pays the remainder. As soon as the tunnel was opened the railroad abandoned the high-line over the Divide, but not until a few weeks ago was the last of the track and ties removed.

As early as 1924 the Denver & Rio Grande Western Ry. started negotiations for use of the tunnel through a joint track agreement, contemplating the construction of the Dotsero Cutoff. The agreement for use of the Moffat track from Utah Junction to Orestod was finally signed October 15, 1928. The trackage agreement provided for improvement of the joint line to equal the D.&R.G.W. standards, cost of the work to be shared by the Rio Grande through increased rental. The Moffat went ahead in 1928 with a heavy program of ballasting and rail replacements, but as delay in starting the cutoff, without which the D.& R.G.W. could not use the Moffat, became prolonged, the betterment program waned.

The cutoff was finally started in 1932 by the Denver & Salt Lake Western, a subsidiary of the Denver & Rio Grande Western, created for the purpose to secure RFC financing. Though now controlled by the D.& R.G.W., the Moffat is actually owned today by the 36-mile D.&S.L.W. through RFC loans for stock purchases. The cutoff was put in service June 15th, 1934, and since then the D.&R.G.W. has routed part of its freight and passenger traffic through the tunnel and over the cutoff. As soon as rental funds for the trackage rights began to come in, the Moffat went ahead in earnest on its betterment program.

Ballasting the line

At mile post 143 (from Denver) the railroad skirts the rim of an extinct volcano. Here in a 20-acre tract in a formation of solid volcanic cin-

Fig. 4. A line change eliminates a bad curve and a high bridge. This is typical of numerous betterments in alignment that have speeded up train operation and reduced maintenance costs.

der a ballast pit of almost unlimited quantity has been opened up to supply the entire railroad. The pit is being worked on a 200-ft. face about 800 ft. long, and through simple methods the ballast is being produced

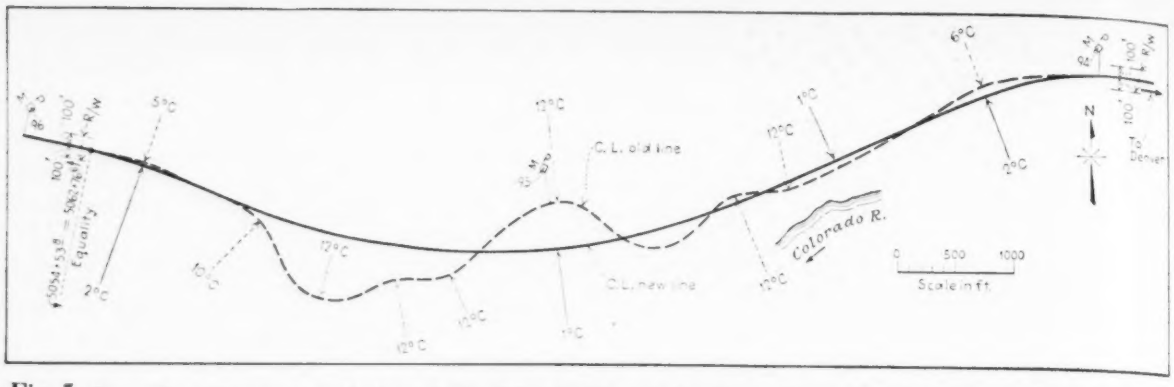


Fig. 5. Two miles of tortuous track through the Colorado River badlands near Kremmling have been replaced by a new high-speed line that crosses the old track in six places. Fig. 1 is a view of part of this improvement.

and loaded for 25c. per cubic yard.

At the start of this year's ballasting in April, 125,000 cu. yd. of material were brought down by a single blast of 29,000 lb. of powder in twelve well holes 40 ft. deep, and 200 ft. of 4x5-ft. coyote tunnels, a yield of 4.3 cu. yd. per lb. of explosive. The blasted cinder rock is loaded by a 1¼-yd. shovel onto a portable belt conveyor discharging into a jaw crusher. Another portable conveyor loads the crusher run directly into ballast dump cars. As the pit tracks are on a 1-per cent grade, it is a simple matter to spot a string of empties at the upper end, drop the cars one by one to the loader, and then drop them down to a collecting track when loaded, all ready for the daily work train. A crew of seven men load eighteen cars or 800 tons a day without effort. A view of the ballast pit is shown in Fig. 6.

Oversized chunks of cinder too big for the 15x30-in. crusher to handle are not broken up, but are hauled away for riprap along banks of streams and for filling of wood trestle bridges. This is but one example of the many economies practiced in the improvement program.

The ballast is of exceptionally high quality. It is porous, yet hard, weighing from 1,850 to 2,250 lb. per cu. yd. In the track it provides perfect drainage and stands up sufficiently to permit tie replacement without disturbing the ballast under adjacent ties. The amount of ballast used averages 3,500 cu. yd. per mile, built up into a cross section of 10½-ft. top width, 1½:1 slopes and 12 in. thickness under bottom of tie.

In preparation for ballasting the track is skeletonized in the usual manner. Ballast is dumped in two lifts, first for an 8-in. raise of track and then a 4-in. raise (Fig. 3). Dumping is at the rate of eight 50-yard cars per hour, including spreading, which is done with flanger plows on the work train locomotive. Raising of the track for the ballast lifts is by hand jacking.

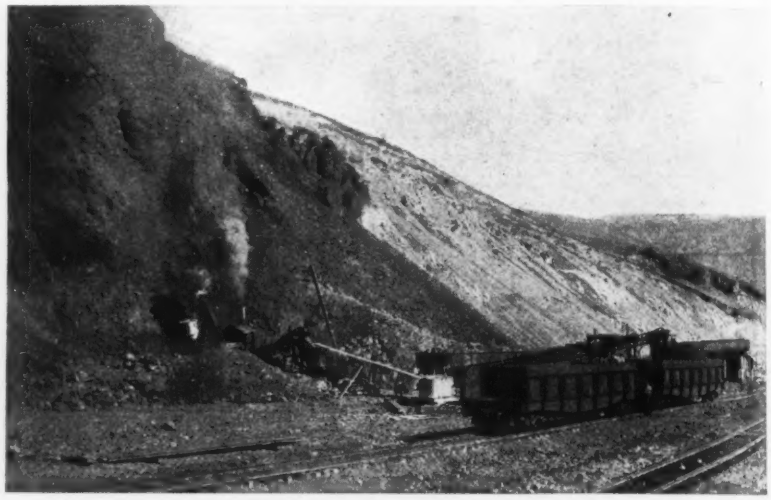


Fig. 6. Ballast of excellent quality in unlimited quantity is available at Cinder Pit, where a 200-ft. quarry face is being worked in an old volcano. Seven men with one shovel, a crusher and two lengths of belt conveyor load 18 cars daily at a cost of 25¢ per yd.

Tamping and finishing is done by an eight-man crew that cleans up 3,000 ft. of track per day with pneumatic tie tampers. A novel plant arrangement has been worked out to keep the compressor off the track and still not have to move it constantly to keep up with the gang. The compressor is set off the rail 1,500 ft. from start of the day's work, and this much 3-in. light-weight quick-detachable pipe is laid between the machine and crew. As the gang works toward the compressor, pipe lengths are removed and laid out in the other direction. Thus from one compressor set-up 3,000 ft. of track, a day's run, can be surfaced. Because of non-interference with the trains the tamping costs have been cut in half by an investment of $829 for the pipe.

Prior to 1926 there wasn't a pound of ballast on the entire railroad. In that and the following year about 33 miles of track in South Boulder Canyon was ballasted with crushed slag. Since 1927 all ballasting has been with the volcanic cinder. Considerable ballast was laid from 1927 to 1930, the remainder since 1935. By the end of the current season there will be only eighteen miles of main line track without ballast, all in South Boulder and Egeria Canyons.

The rail laid as the road was built from Denver to Steamboat Springs (1903-1909) was 80-lb. A.S.C.E. sec-

tion; from Steamboat Springs to Craig (1913) it was 85-lb. A.S.C.E. Replacement of the old 80-lb. rail with 100-lb. A.R.A.-"B" section was started in 1927 when 25 miles of track was renewed. In 1930 rail renewal reached M.P. 66, and no further replacements were made until 1935. In the last three years the heavy rail has been completed as far as Orestod, the end of the joint line operation. The No. 1 80-lb. relay rail released east of Orestod has been used west of that point to replace badly worn rail lengths and has also been used for numerous passing

Fig. 7. Nearly 300 old timber bridges like this one are being eliminated by culverts and fills. Culverts are usually corrugated metal pipe, strutted from within to take the first shock of dumping the fill from bridge level. Fill material comes from cut widening and ditching operations.

track extensions. Incidentally, in scrapping the worn-out rail the railroad makes money this year, for the replacement costs $10 per ton and the scrap sells for $21.

A well-organized tracklaying crew is turning out some real production. In one 10-hour day a 63-man gang relaid 6,005 track ft. of rail. Traffic during that period totaled ten trains, necessitating cutting in ten times. Trains operated freely through the area without dispatcher's orders, for a signal man with a portable phone set stayed with the gang and kept track of trains by tapping the dispatching wires.

Through the relaying of released rail the track west of Orestod is now in fairly good shape. However, the road plans to replace all of the lighter rail with 100-lb section at the rate of ten miles per year.

Very little replacement of ties had been done since the original installations, and as a result, the ties, in general, were in bad shape at the start of the rehabilitation program. The worst ties were temporarily replaced to maintain a safe track, but the tie renewal schedule was held off until 1936, when replacement of the entire line with creosoted sleepers was started. Last year 172,000 creosoted ties were inserted at various points in the line, and an equal number are going in this year. By the end of 1937 more than 36 per cent of the main track will be supported by new treated ties.

Red spruce, pinyon and fir ties are used on curves, sized, adzed and bored for spikes before treating. New tangent ties are creosoted native pine, bored before creosoting. A commercial creosoting plant at Utah Junction does all the treating. It is interesting to note the salvage value of ties removed from the abandoned high-line, where the number of usable ties increased with the altitude. Up to El. 10,000 there were few worth reclaiming, but from this elevation to the top (El. 11,660) most of the old ties were well preserved. Above El. 11,000 about 80 per cent were usable. Many of the reclaimed ties were sent to the creosoting plant and put into main line service.

Replacements are not in a continuous length of track, but are made in the worst stretches, long enough to make it worth while to bring in the tie gang. Three gangs of 24 men each, working with hand tools only, make all the renewals, and they average 1.1 tie per man-hr. A maximum day's work was 2.5 ties per man per hour.

Several economies have been put into effect in connection with tie renewals. When there is any demand the old ties are given away, thus saving a cost of 5c. each for stacking and burning. Numerous stretches of snow fence have been built out of old ties, similar to the old rail fences in New England. Section foremen spend their leisure time in winter splitting old oak ties into usable fence posts, about 12,000 such posts being obtained from this source last winter and spring.

Line changes

Operating conditions have been greatly improved by several line changes involving some reduction in

Fig. 8. No excuse now for the section foremen not keeping the curves in perfect condition, for every curve is referenced on a rail post that carries pertinent information.

grade, elimination of numerous curves and considerable reductions in total curvature. There are only two 16-deg., one 15-deg., and one 13-deg. curves left; the remaining maximum is 12 deg.

The most important grade change was at Utah Junction, where a new double track line replaces the old

Fig. 9. Gore Canyon's ruggedness precludes much change in line or grade, but reballasting and cutting down the subgrade for additional tunnel clearance are useful improvements.

main line through the yards. The new line ties in with a grade change three miles long which eliminates the old Federal Boulevard grade crossing and abolishes a stretch of 1.21 per cent adverse grade. Some 400,000 cu. yd. of fill was required for this change, in which the tracks were raised a maximum of 20 ft. Three new bridges were required.

Another significant change in grade was made at Pallas Summit, near Phippsburg, where a 2.5-per cent adverse grade was reduced to 1.8 per cent by cutting down the hill 4½ ft. and installing a 3,000-ft. vertical curve. Freight engines can now haul five cars more than they formerly could.

A major line change through the "Badlands" from M.P. 94 to 96, eliminated 421 deg. of curvature, shortened the line 823 ft. and cut out several 12-deg. curves. The new line, involving 400,000 cu. yd. of excavation, crosses the old winding route in six places (Fig. 5). Train speed has been raised from 20 m.p.h. to 60 m.p.h. by this change. Another line change from M.P. 90.31 to 92.61 eliminated 156 deg of curvature. A 16-deg. curve at M.P. 29.2 was reduced to 9 deg. by a new cut.

These are typical of the major line changes. In addition the track has been bettered at scores of points by lengthening and reducing curves, by widening the roadbed and cuts, by ditching and drainage. Most of the old sidings and passing track have been extended and many new ones installed. There are now 100-car passing tracks at an average of five miles apart. A new interchange at Orestod saves considerable switching of cars between the two railroads, much of which formerly tied up the main lines. The roadbed through Gore Canyon has been cut down to provide more clearance through the numerous tunnels.

All curves, formerly simple or compound, have been spiraled, compensated for grade and properly superelevated. They are all monumented along the center line, and a painted rail reference post carries all pertinent information to enable section foremen to maintain each curve as it should be (Fig. 8).

Many bridges eliminated

Timber bridges were cheaper and easier to build in the old days than were culverts and fills. At the time the line was completed to Craig, it contained 272 timber structures aggregating 21,640 ft., or slightly more than four miles in length. Usual construction, all of native untreated timber, was four-post bents resting on wood sills.

Naturally, in the dry, high climate these numerous bridges were a serious fire hazard, and in addition they were becoming an expensive maintenance item. Therefore, replacement of many of the bridges with culverts and fills was made a major part of the improvement program. This work is nearing completion, and 175 bridges totaling 2.4 miles long have been filled and three more have been abandoned by line changes. Of the 94 structures remaining (9,950 ft.) about half are over streams too large for culverts to carry, several have been improved with steel beam stringers, others are to be eliminated and in most cases the old timber sills of those remaining have been replaced by concrete pedestals.

The first step in eliminating a bridge is to install the culvert, which, with few exceptions, consists of corrugated iron pipe ranging from one 30-in. line to two 72-in. pipes. (Fig. 7). The larger sizes are strutted from within to take the shock of the first dumping of fill. Occasionally a single or double concrete box forms the culvert. Filling is all by dumping from work trains. Fill material comes from ditching operations, cut widening, line changes and the ballast pit. Before the fill is complete the bridge ties are replaced with road ties. Stringers and ties are the only timber salvaged.

Tunnel maintenance

The Moffat road traverses 10.72 miles of tunnel at 52 locations. The Moffat tunnel, of course, is the longest, 32,798 ft; others range from 78 to 1,727 ft. Of the 56,618 ft. total length of tunnel, 14,567 ft. is lined with Gunite, 18,232 ft. with concrete, 12,514 ft. with old timber, and 11,306 ft. is unlined. All of the 2½ miles of timber is untreated and at least 34 years old. While much of this timber is still in good shape, a considerable amount needs early replacement. Bridge gangs have already started rebuilding some of the old timber portals and replacing lining sets near the tunnel ends.

In the Moffat tunnel, a 6-in. accumulation of soot and cinders is being cleaned out, along with part of the original tunnel muck ballast. This ballast contains many large pieces, which, with the soot and cinders, made it difficult to hold the track in line. The waste material is hauled out in small cars pulled by a gasoline motor. Standard volcanic

cinder ballast replaces the removed material.

Other features of the railroad have not been neglected in the improvement program. New coaling stations and water tanks are being built, section houses are getting their first repairing and painting in 30 years, decrepit stock pens are being rebuilt, and the entire telegraph and telephone system has been renewed. New automatic coaling stations at Utah Junction and Phippsburg replace cumbersome crane and clamshell equipment and reduce the coaling cost from 35c. a ton to 4c. Noteworthy economies have been effected by these new water tanks. A steel one at Utah Junction of 70,000-gal. capacity is supplied by an air lift pump that operates on surplus air from the nearby shops. A new 50,000-gal. redwood tank at Pinecliff feeds through a 38,000-ft. gravity line, replacing an old expensive pumping plant, and a similar new tank at Sulphur Springs is operated by an automatic electric pump.

Plans for further improvement of the road are now under consideration. The present program will be continued until the Orestod-Craig section compares with the eastern half in rail and ballast. There are no more immediate possibilities for line changes but at several points adverse grades may be cut down. Electrification of the Moffat tunnel is needed, for the ventilation plant is now inadequate on days of heavy traffic, reaching 32 trains. If electric operation is adopted for the tunnel, there is a possibility of electrifying the entire 128 miles of jointly operated line. Strengthening of some bridges is necessary before the D.&R.G.W. can use its heaviest freight engines. However, the present improvements make a first-class line of the Moffat.

Direction

With the collaboration of Wilson McCarthy, the railroad's progressive president, and except for some of the larger line changes, grade crossing elimination, coal and water stations, which were partly done by contract, all of the improvement work has been carried out by railroad forces under the direction of W. C. Jones, chief engineer, assisted by G. S. Turner (since 1935), engineer of maintenance of way, and Ed Sunergren, office engineer.

Building Trades Work and Wages

Average hourly rate paid in 1936, was 91.8c, 5,450 contractors' payroll records show

THE AVERAGE HOURLY RATE paid to building trades employees in 1936 was 91.8 c., according to a survey made by the U. S. Bureau of Labor Statistics and the WPA. Results of the survey are given in an article by Edward P. Sanford in the August, 1937, issue of the *Monthly Labor Review*, published by the Department of Labor. Payroll records of 5,450 contractors in 105 cities, and involving 186,145 employees doing work valued at $338,829,331 were studied in the compilation of the report. Building construction only was considered. It is estimated the number of employees reported amounts to 25 or 30 per cent of the total number engaged in building trades work throughout the country.

Of the total number of workers scheduled, 67.7 per cent were union; 56.8 per cent were skilled and 23 per cent were classed as semi-skilled. A feature of the study is the large proportion of workers falling within the relatively high wage brackets. Nearly half (46.9 per cent) received rates of $1 an hour or more, and almost two-thirds were paid more than 75c. Only 12.3 per cent received less than 50 c. per hr. Hoisting engineers were paid the highest average wage, $1.343, and structural ironworkers were a close second with $1.332. The number of workers and average wage rates for several classifications are given in the accompanying table.

Workmen on public works fared slightly better than those on private projects, the average pay being 93.3 c. and 90.4 c., respectively. Skilled men on public projects received an average of $1.227; on private work $1.016. Union members were paid a higher average rate than were nonunion workers in all classifications, as shown in the table below.

There was a considerable geographical differential in wages. The highest average for any region was $1.062 in the Middle Atlantic region; the lowest was 64.5 c. in the East South Central zone.

BUILDING TRADES EMPLOYEES AND WAGE RATES, 1936

	Employees			Hourly Wages		
	Total	Union	Non-union	Total Ave.	Union	Non-union
Bricklayers	14,811	12,959	1,852	$1.304	$1.351	$0.972
Carpenters	33,040	23,258	9,782	1.048	1.150	.805
Cement finishers	4,024	3,087	937	1.119	1.222	.783
Helpers	3,327	2,856	471	.865	.922	.519
Electricians	6,814	5,980	834	1.300	1.361	.862
Helpers	1,486	991	495	.643	.720	.502
Hoisting engineers	988	831	157	1.345	1.419	.942
Helpers (not otherwise classified)	20,670	12,616	8,054	.667	.781	.489
Hod carriers	7,361	5,499	1,862	.781	.850	.577
Laborers, common	37,633	17,389	20,244	.516	.629	.420
Lathers, wood	589	398	191	1.091	1.277	.704
Lathers, metal	2,525	2,282	243	1.304	1.342	.949
Mixer operators	510	281	229	.871	1.053	.667
Painters	9,542	5,688	3,854	.935	1.092	.702
Plasterers	6,800	5,797	1,003	1.292	1.354	.938
Plumbers	6,042	4,942	1,100	1.224	1.284	.954
Helpers	2,358	1,318	940	.612	.699	.482
Reinf. steel workers	1,981	1,151	469	1.089	1.155	.876
Roofers, comp	2,636	1,478	1,158	.944	1.123	.716
Roofers, tile, slate	531	306	225	1.085	1.213	.907
Sheet metal workers	3,482	2,360	1,122	1.079	1.202	.819
Helpers	1,518	547	971	.511	.607	.457
Steamfitters	3,388	2,983	405	1.260	1.302	.950
Helpers	1,938	1,428	510	.723	.786	.548
Stonemasons	1,219	1,026	193	1.278	1.354	.870
Structural ironworkers	4,806	3,717	1,089	1.132	1.396	1.111
Tile layers	1,934	1,673	2.61	1.205	1.248	927
Helpers	2,007	1,540	467	.719	.792	.477
Truck drivers:						
Under 1½ tons	255	111	144	.518	.580	.471
1½ to 5 tons	1,700	886	814	.630	.718	.535
Over 5 tons	230	175	55	.822	.876	.648
Total and average	186,145	126,014	60,131	$0.918	$1.064	$0.612

FIG. 1. CONCRETE SIDE SLABS HAVE BEEN POURED TO WIDEN DECK FOR HIGHWAY USE; CENTER IS POURED LATER

Overseas Road to Key West

by HAROLD CHAMBERLIN
San Diego, Calif.

Over thirty miles of the famous railway spanning the Florida Keys are being converted into a modern paved highway

The closing of the last link in a highway that traverses the Atlantic coast states from the northernmost point of Maine to Key West at the tip of Florida is now in active progress. Known as the Overseas Highway, this closing link has secondary interest because it is a restoration for highway service of some 33 mi. of the Florida East Coast Ry., built along the Florida Keys a quarter of a century ago by Henry M. Flagler in his ambitious plan to develop south Florida. The following article describes the work. — EDITOR

CONSTRUCTION is in active progress to convert some 33 mi. of the former bridges and roadbed of the Florida East Coast Ry. into a paved roadway of standard width for automobiles. The railway was completed to Key West, Fla., in 1912. Hailed as one of the engineering marvels of the day the extension over the keys cost, from Florida City south of Miami to Key West, some $26,000,000. Freight and passenger revenues from the line never even approximately justified the outlay.

When the Labor Day hurricane of 1935 swept across the Florida keys killing more than 500 persons the railway was so damaged that service down the length of the keys was abandoned. After more than 20 years during which Key West had been linked to continental United States by steel rails, the Island City was once more isolated except for ships and long ferry jumps.

Road transport takes over

When it became apparent following the 1935 storm that the Florida East Coast Ry. would not be able to finance the rebuilding of its line, a movement was put on foot to acquire the bridge structures and convert them for highway use. An application was made to the federal government for funds to finance this conversion. Abandonment was finally approved by the courts and permission given for the sale of this right-of-way to the Overseas Road and Toll Bridge District, contingent upon approval of the abandonment by the Interstate Commerce Commission. After a hearing the abandonment was allowed.

The Public Works Administration offered to purchase the bonds which the district proposed to issue to finance construction. Immediately preliminary plans were completed and bids called for. At the present time contracts have been let covering the entire project and construction work is well under way.

The total cost of the Overseas Highway when completed will be about $7,400,000. Of this amount $600,000 represents the purchase price paid by the district for the abandoned railroad bridges and right-of-way; $3,000,000 is the cost of construction work necessary to convert for highway use, and $3,800,000 was the cost of highway and bridges previously constructed and not involved in the present project. Engineers have estimated that it would have cost an additional $7,000,000 today to build the foundations and bridges acquired from the railroad for $600,000.

In explanation of these cost figures it should be observed that previous to 1935 construction of the

Overseas Highway had been going forward bit by bit. From Key West the roadway had been pushed across the lower keys for about 40 mi. toward the mainland. Similarly at the other end one gap after another had been closed until only about 45 mi. between Lower Matecumbe Key and No Name Key was unfinished, and even a portion of this distance was complete so that automobile traffic travelled by ferry from lower Matecumbe to Grassy Key, then over 13 mi. of roadway to Hog Key, and from this point took ferry again to No Name Key. The present project totaling about 32.6 mi. is in two sections with the 13 mi. of previously completed highway in the center.

Bridge renovation leads

Practically 13 mi. of bridge structures are included in the 32.6 mi. of roadway now being built. The balance is the old railroad roadbed already brought to grade and requiring very little work except to lay the paving. In the vicinity of the Matecumbe keys, where considerable sections of fill were washed away in the hurricane, it was not necessary for highway purposes to restore the old embankments completely. Here also bridge structures were practically undamaged for conversion purposes, though the railroad would have been required to replace ties and rails swept away.

The longest bridge in the project is about 7 mi. and reaches from Knight's Key to Little Duck Key crossing Moser channel and Pacet channel. For the most part this structure is heavy 80-ft. steel girders resting on concrete piers, but there are also a little more than 9,000 ft. of 35-ft. plain concrete arch spans.

These two types of bridge structures (steel girders and concrete arches) are typical of most of the project, and in drawing the plans to convert these bridges to highway use it was necessary only to provide support for a 20-ft. roadway as opposed to the former single-track railroad. This has been accomplished by laying steel beams 10 ft. apart across the old structures. Some of these beams are 25 ft. long, some are longer, depending on the width and type of the abandoned railroad bridges.

The cross beams when placed on top of steel girder spans are welded to the already existing structure and are further supported at each outside end by a steel brace which reaches to the bottom of the old girder. In the case of the arch bridges the cross beams are set in slots cut in the old concrete by air chisels. Once in the slots the beams are cemented in place so they are encased in solid concrete.

Before they are used, all the steel cross beams are given a waterproof treatment to protect them against salt water corrosion. This is accomplished with three coats of asphalt paint, and between each coat the beam is covered with a fabric already saturated with asphalt.

If it had not been for the Bahia Honda bridge the entire project would have been comparatively simple, for the design and placing of the foundation beams which carry the roadway across most of the old bridge structures involved no radical or unusual features.

Road follows truss tops

The Bahia Honda bridge, a little less than a mile in length, presented difficulties of its own. This structure is composed chiefly of steel-truss through spans, 13 of them 125 ft. in length, 13, 182 ft. in length, and a single span 252 ft. in length, together with a few steel girder approach spans at each end. The trusses are through trusses between which the single railroad track passed, and if the highway were carried similarly the road would have been so narrow that only one-way traffic would have been possible.

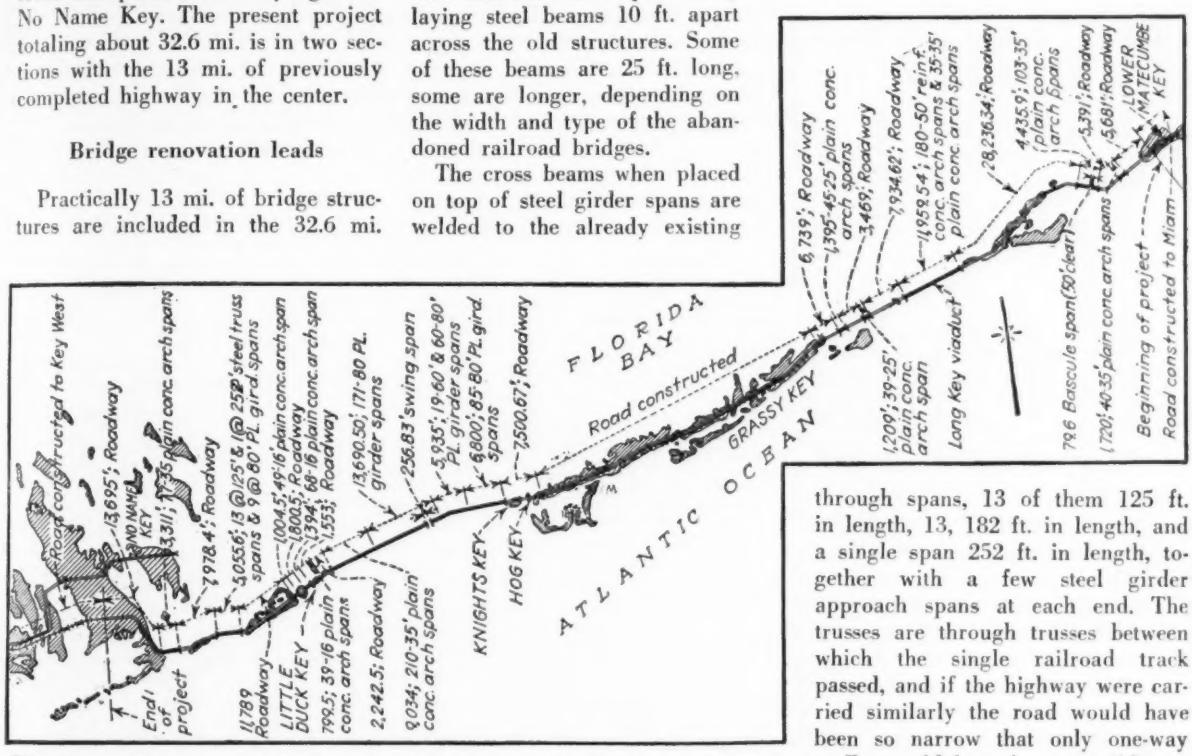

Road constructed to Key West
13,695'; Roadway
NO NAME KEY
3,311'; 17-35' plain conc. arch spans
7,978.4'; Roadway
50,556'; 13 @ 125' & 1 @ 252' steel truss spans & 9 @ 80' PL. gird. spans
1,004.5'; 49-1/6' plain conc. arch span
1,800.5'; Roadway
394'; 68-1/6' plain conc. arch span
1,553'; Roadway
13,690.50'; 171-80' PL. girder spans
256.83' swing span
5,935'; 19-60' & 60-80' PL. girder spans
6,800'; 85-80' PL. gird. spans
7,500.67'; Roadway
FLORIDA BAY
Road constructed
KNIGHT'S KEY
HOG KEY
ATLANTIC OCEAN
GRASSY KEY
6,739'; Roadway
1,395'; 45-25' plain conc. arch spans
3,469'; Roadway
7,934.62'; Roadway
1,959.54'; 180-50' reinf. conc. arch spans & 35-35' plain conc. arch spans
28,236.34'; Roadway
4,435.9'; 103-35' plain conc. arch spans
5,391'; Roadway
5,681'; Roadway
LOWER MATECUMBE KEY
1,200'; 39-25' plain conc. arch span
Long Key viaduct
786 Bascule span (80' clear)
1,720'; 40-35' plain conc. arch spans
Beginning of project
Road constructed to Miami
End of project
11,789' Roadway
LITTLE DUCK KEY
799.5'; 39-1/6' plain conc. arch spans
2,242.5'; Roadway
9,034'; 210-35' plain conc. arch spans

Fig. 2. Section of railway taken over to be reconstructed for highway use as part of the Florida coast highway to Key West.

After studying the problems involved it was determined to carry the new road up and over the tops of the old trusses. The design was complicated by the fact that horizontal curves existed in the approaches at each end of the bridge structure and also because the trusses were of varying heights, which necessitated six vertical curves in the profile of the new roadway.

Briefly it may be explained that in order to graduate the approach to and the descent from the roadway across the top of the trusses the engineers are utilizing the existing approach girders which are being raised from the concrete piers and placed on steel towers erected on the old piers. Framing between trusses

Fig. 3. Old railway being regraded for surfacing as a highway; level profile, flat curves and no crossing roads prevail.

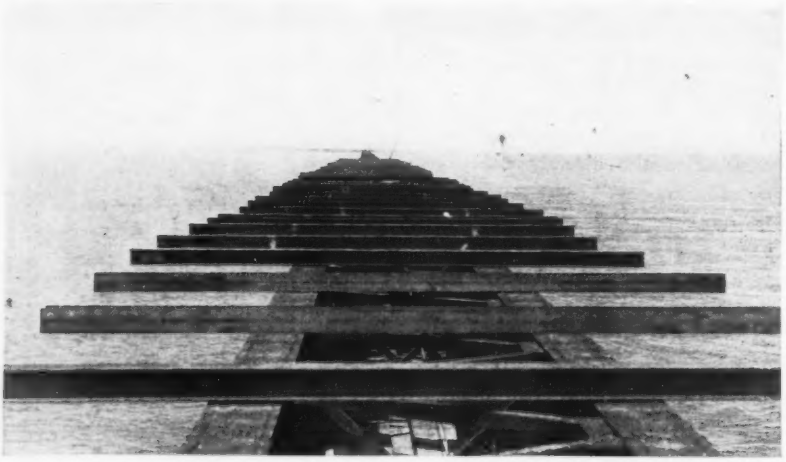


Fig. 4. Steel beams welded to railway plate-girder deck spans carry the wider concrete deck slab for the new highway.

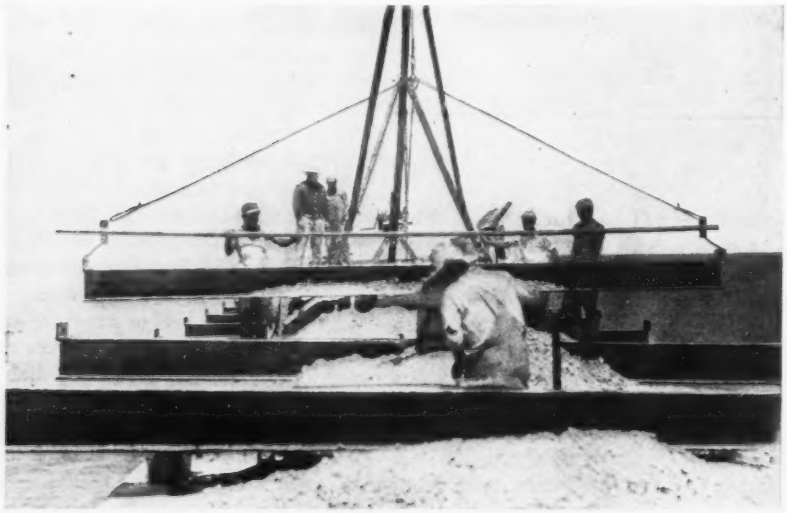


Fig. 5. Placing steel cross beams on concrete arch bridges; men in the foreground are cutting slots in the concrete to receive the beams.

will provide a continuous foundation on which to lay steel cross beams as on the other bridges and the actual roadway over the top of the bridge will then be poured with concrete in the same manner as on the rest of the project. The highest elevation on this bridge will be 65 ft. above the water and this will be the high point on the drive across the keys.

Paving details simple

The new road will be 20 ft. wide on all bridge structures and 21 ft. on the ground. This conforms to standard specifications of the Florida state road department. On the fills and keys the highway will be of rock base construction with a surface treated pavement. On the bridges it will be of reinforced concrete.

The nature of the concrete work varies somewhat with the different types of bridges, but it may be explained that in every case the width of the roadway is covered by three different slabs of which the center slab conforms to the width of the existing structure and the two side slabs are poured over the cross beams extending to each side. By using three separate sections in this manner the designers expect to minimize possible damage from future storms.

Between the beams on each side wood forms are built to carry the weight of the concrete slab 10 in. thick; between beams the slab is reinforced with steel rods. Curing takes place under sacks for 28 days, after which the forms are removed and waterproofing is applied to keep out dampness.

On the bridges there will be a concrete curbing at each side 9 in. high and 20 in. wide. The 7-mile-long Knight's Key bridge will have a steel guard rail on each side but on all others the guard rail will be of concrete.

No definite announcement has been made as to the date of comple-

tion of the project. It is expected, however, that the upper portion between Lower Matecumbe and Grassy Key will be finished in about six or eight months, thus eliminating one of the two ferry jumps now necessary to reach Key West. The lower section including the 7-mile-long Knight's Key bridge and the Bahia Honda bridge is expected to be open for traffic before the end of 1938.

Toll charges necessary to liquidate the bonds sold to finance construction have not yet been fixed, although it is tentatively considered that toll for a passenger car and driver will not exceed $1, with perhaps an additional charge of 25c. per extra passenger. The Overseas Highway commission states that the figure will depend on the volume of traffic handled and the charge will be the lowest possible to permit retirement of the bonds within a 30-year period and allow for necessary maintenance work in the meantime.

In any event the Overseas Highway soon will join the roster of those works of engineering which are unusual enough to be remembered. This project, so it is said, will include the longest continuous overseas bridge for motor traffic yet constructed. The highway will shorten travel time between Key West and Miami to a mere three or four hours.

Plans for converting the railroad roadbed and bridges to highway use were drawn by B. M. Duncan, former consulting engineer of the state road department and now chief engineer and general manager for the Overseas Road and Toll Bridge District. He has been assisted in the work by A. L. West.

What is Cost Engineering?

By H. P. Maxton

General Cost Engineer, Construction Plant Division, Tennessee Valley Authority, Knoxville, Tenn.

Cost engineering defined as management to keep down construction costs. Ways and means of functioning developed from experience are outlined

Cost engineering is not new. The old time constructors who are reputed to have kept all their records on the backs of envelopes were cost engineers of sorts; they knew how their operations were going on and they made money and that is all that cost engineering in its present most refined practice can accomplish. But today the practices have to be refined; the old envelope method of cost-keeping if it ever actually existed is no longer sufficient. There is reason then for considering cost engineering anew.

Common conceptions of cost engineering are confused because the fundamental function gets befogged in the working processes. Bookkeeping, cost-keeping, accounting, reports, records and what-have-you are means to a purpose but are not the real purpose; this is management of construction to keep down costs—in contracting, to make a profit. The collected figures and records give the cost engineer the knowledge of the economics of operations and performance by which he plans plant installation, processes and working schedules that will reduce costs of current and future work. And here let it be emphasized that on all construction jobs questions constantly arise how certain operations can be conducted most efficiently. One of the most important functions of the cost engineer is to advise with the construction superintendent and the management on the most economical methods of doing work.

A program essential

To be always in a position to advise intelligently, the cost engineer must have a definite program of duties and a complete system of records. A planned program may often be about as follows:

1. *Preparation of a Financial Schedule* — The management must know how much money is needed to begin and carry on the job; how much and when the earnings or income can be expected and when the earnings can be expected to equal or exceed the expenditures. The banker wants to know how the job was figured, how long his money is needed and when he can expect the loan repaid. A budget must be carefully prepared and just as carefully followed. It serves as an excellent thermometer of the condition of the job and gives the management its most effective tool for job control.

A chart (Fig. 1) should be designed based on the extension of the estimated unit costs on the progress schedule and including the expected income and actual earnings. This chart was originally published in the April 1936 issue of *Construction Methods* in "Planning and Plant for Heavy Construction" by A. J. Ackerman and C. H. Locher, of the Tennessee Valley Authority.

2. *Review the Estimate and the Progress Schedule*—(If the cost engineer prepared or assisted in preparing the original estimate this may not be necessary). Advise with the planning engineers and superintendent regarding construction methods, progress, plant and costs. They must have suitable cost data supplied to them to control their judgment. The cost engineer must be prepared to submit to them illustrative records of construction methods, efficiency, costs and progress.

3. *Outline a Series of Reports to be Made to the Contractor*—These may be of the following classes:

(a) Labor control reports: (1) a record of daily labor distribution and (2) reports of daily and weekly unit cost

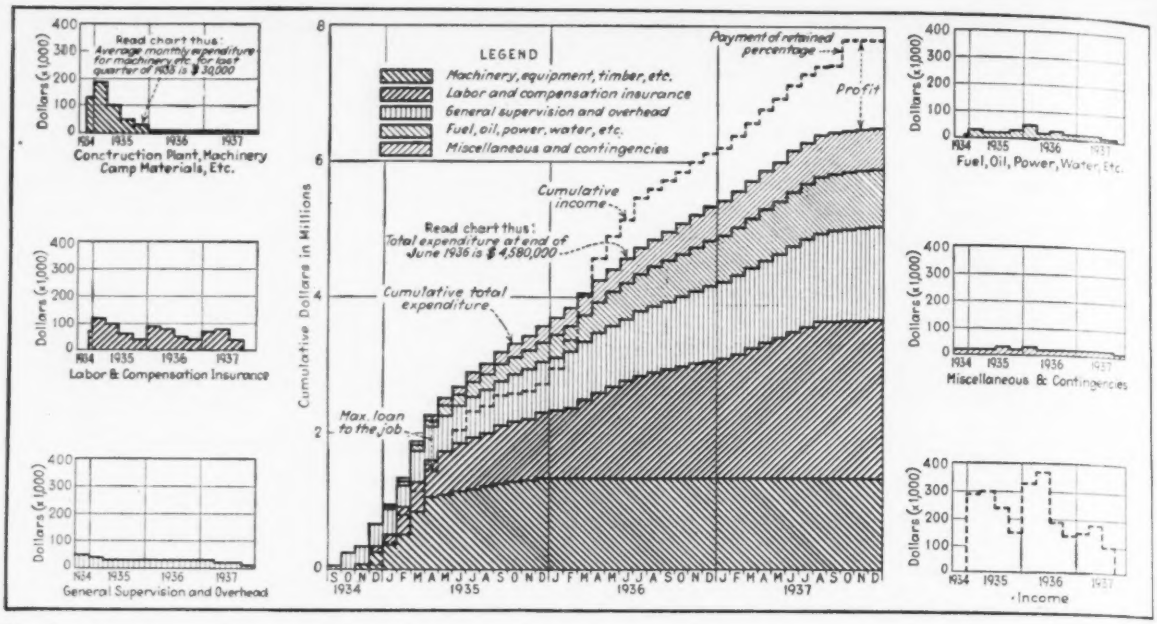


Fig. 1. Job progress and cost chart is of vital service in the general financial management of a construction operation.

(b) Detailed cost analyses to be issued periodically or when the progress of the various items of work warrants their preparation. These reports of costs must reflect actual job conditions.

(c) A frequent comparison of unit costs with the original estimate or other similar work is a safeguard; too often the constructor suddenly realizes that an operation is absorbing the expected profit and belated steps are taken to curb the leak; if promptly recognized, the trouble can be overcome by simple changes.

(d) Graphs and curves of costs; Fig. 2 is an example.

(e) Studies of cost trends, with the use of graphs, compared with the original estimate and the cost of similar work on other jobs, indicate which items of work must be reduced in cost.

(f) Special reports of economic studies should be prepared for the use of the superintendent. These may include labor studies of work accomplished, relation of minimum operating crews to actual costs to indicate efficiency in the use of materials and supplies, and in methods of construction.

(g) Final reports, for recording and reference.

4. *Method of Making Reports*—To be effective, reports must be clear and condensed and yet present a comprehensive record of conditions and facts. Historical records must be written in sufficient detail to present a complete record of activities, methods of construction, costs, and a record of the method by which the costs were allocated.

5. *General Policies*—Many methods of procedure must be studied and decided upon to assure fair and consistent costs, and such methods of handling established for historical record. Some of the items to be decided upon are: (a) Plant and equipment, method of depreciation, extent of depreciation; dismantling, salvage, and method of handling operating costs; (b) warehouse handling; (c) direct charging; (d) job overhead, and (e) cooperation with the accountant and the field and office engineers. The results expected and the value of those results are: (a) units to use in reporting costs; (b) frequency of reports, and (c) value of the reports.

The efforts of the cost engineer ultimately focus toward one major goal—to supply records of such simplicity and accuracy and in such an intelligent manner of presentation as to give full and perfect control over all costs. If this goal is achieved it is certain that all other requirements, such as budget reports, final reference and estimating records, reports of the home office, etc., will be fulfilled.

All reports must be accurate and cover the physical elements of the work. They must be presented simply enough to be readily digested and interesting enough to insure their use.

Kind of reports

Proper planning of records and reports plays a large part in the ultimate success of the results produced. The progression of the job closes many doors to otherwise valuable data, and only previous planning will enable this information to be secured when it is available.

Labor Reports—If the choice of reports for job economy were limited to only one, that report would certainly be for labor control. With about one-third of the construction job expenditures going out in payrolls it is readily understood that careful watch of this controllable item is necessary to obtain good costs. Furthermore, the superintendent who keeps control over his labor usually watches his expendable material and supplies, efficiency of equipment operation and general job conditions. The daily, weekly and monthly labor unit cost report is by far the record of greatest usefulness to the construction superintendent. It is not to be inferred that it is possible or practicable to record all payroll in terms of unit costs. Rather, labor items of a constantly recurring nature should be watched carefully, viz., plant and equipment operation, form erection and stripping, concrete placing and

curing, masonry cleaning, earth and rock work, reinforcing and structural steel handling and installation, transportation to job, etc. The efficiency of other labor such as plant and equipment maintenance and repairing; machine shop and carpenter shop work; job electricians and riggers doing miscellaneous upkeep and maintenance work, must be summed up in various types of studies in such a manner that their relationship to the total cost is readily understood.

Daily labor distribution reports have a distinct value to both the cost engineer and the superintendent. A daily survey of the distribution of labor will, first, verify in a general way the proper distribution of the labor and, secondly, convey a surprising amount of information.

Equipment Efficiency Reports—The typical construction job of today uses large expensive equipment and machinery. The difference between profit and bankruptcy can easily be found in the economical and efficient handling and operation of these units. The establishment of minimum operating crews provides the necessary operating labor control. Then a daily or shift by shift reporting of the operating efficiency in terms of net operating hours and work done provides an excellent guide as to the efficiency of the machine. Repair labor, parts and operating expense can be easily recorded and watched for each plant unit or piece of major equipment.

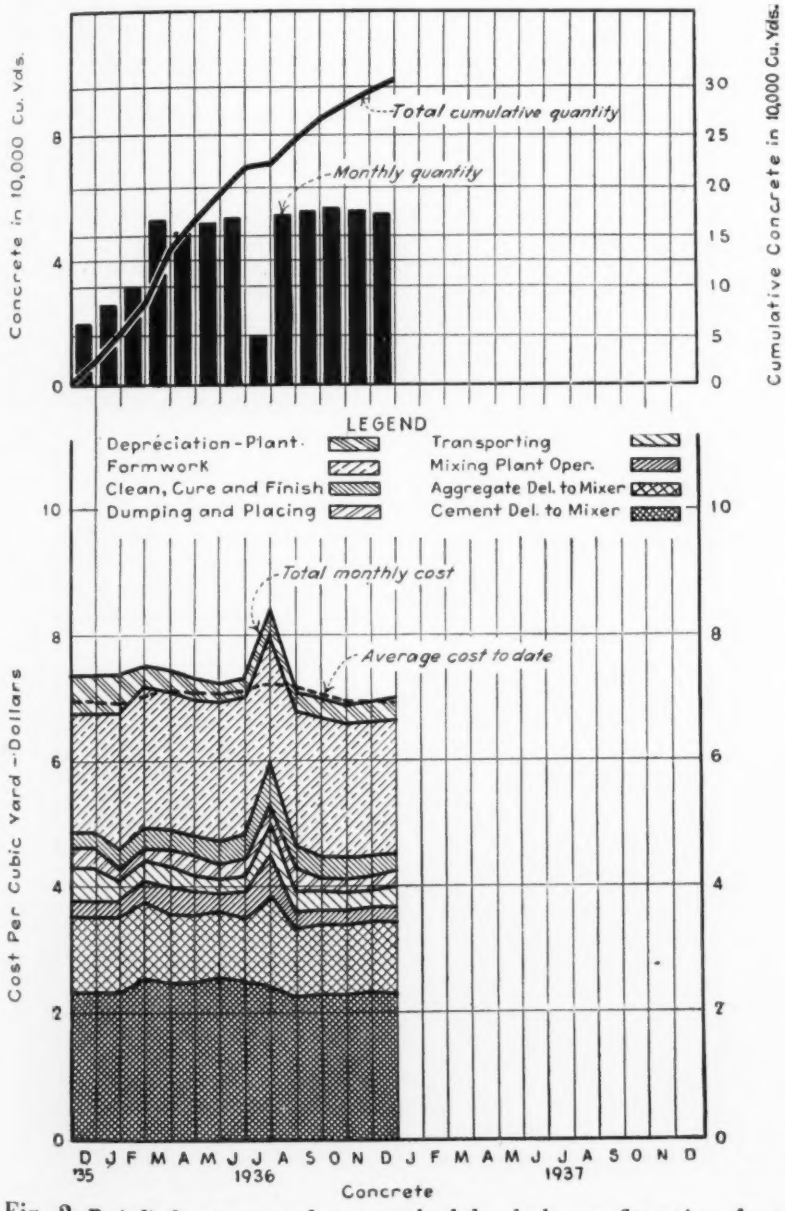


Fig. 2. Periodical progress and cost graphs help check cost fluctuations from the average throughout the year.

Analyzed Unit Costs—The preparation of unit costs requires an intelligent application of job conditions and quantities to job costs. The development of any unit costs without analyzing their source and background is usually valueless and apt to be misleading to a dangerous degree. The presentation of unreliable and inaccurate costs by a cost engineer is inexcusable. It would be far better if no attempt be made to issue reports that profess to offer information if they cannot be based on sound interpretation.

Time Studies—Labor time studies, wisely planned and executed, open a field for large savings in efficiency not developed by many contractors, and yet such ideas have been put into practical use by manufacturers for years. The actual method of making time studies is very different from factory methods, however; observations made in the field by trained men of labor operations of repeated recurrence such as form erection and stripping, rock drilling, structural steel erection and riveting, hand excavation, etc., pay tremendous dividends.

Piecework and Bonus—Frequently payment to labor on the piecework basis reduces costs and results in a larger pay envelope to the laborer. Piecework and bonus systems can be made to operate very satisfactorily where they are based on the principle of employee participation in enterprise and profit.

Competition — Competition is a mighty healthy sign on a construction job and it is not always necessary to pay a bonus to secure it. A smart superintendent recently had a large earthmoving job to do. Each shift he had a checker on a tower erected for the purpose of counting loads as they were hauled between the borrowpit and the embankment. The competition for supremacy grew so keen that two checkers almost came to blows when both laid claim to a certain load passing the check-

ing tower at the change of shift. It is important to keep the men posted regarding their work in relationship to the other crews or shifts, regardless of whether a bonus is paid or not. Indeed, the posting by figures or graphs of the accomplishments of men will very often be the start of voluntary competition.

Charts—Cost Trends—The use of graphs and curves in presenting costs, equipment operation and production is undoubtedly one of the most effective methods in developing the value of costs. Very often the development of a series of cost figures on a chart conveys startling results not so easily ascertainable in the form of figures. Personnel, payrolls, quantities, equipment operation and efficiency should likewise be converted to graphic form.

Civic Center in Oklahoma City

by GERRY M. ORR

Chief, Review Section, PWA, Oklahoma City, Oklahoma

New city and county government buildings centralized in business section of city at cost of $7,700,000

ONE of the foremost examples of municipal planning in this country is the new civic center recently completed in Oklahoma City. Located in the very center of the city's business section, the project includes three buildings for municipal purposes and a 12-story building for the use of the county.

The entire cost is placed at $7,700,000, of which $3,700,000 represents the price paid for land purchased from railway companies. The buildings have been financed by PWA to the extent of 45 per cent of their cost. All architectural and contracting services were provided by Oklahoma City firms.

The municipal auditorium, built at a cost of $1,250,000, will seat 7,500 people and is equipped for sound, insulated for acoustics, and air conditioned. J. O. Parr was the architect and the Warren S. Bellows Construction Co. general contractor. The city hall and police headquarters buildings, built under a combined contract for $860,000, were designed by Allied Architects and constructed by the Charles M. Dunning Co. A central heating plant for the three city buildings has been installed in the police headquarters structure.

The county courthouse, a 12-story structure built at a cost of $1,000,000, will house all the county offices and the district and county courts. Layton & Forsyth were the architects and the general contractor was the Manhattan Construction Co.

The city's plan is not yet complete, however. Space has been reserved in the civic center, between the new municipal auditorium and the city hall, for the erection of a public library. In addition, the federal government has recently had under consideration the acquirement of land in the center suitable for the erection of a new federal building to house the court and Indian agency.

Engineering inspection of the project, provided by PWA, was handled by August Cohn, Richard Everett and J. S. Waldrek. The latter now holds the office of city engineer of Oklahoma City.

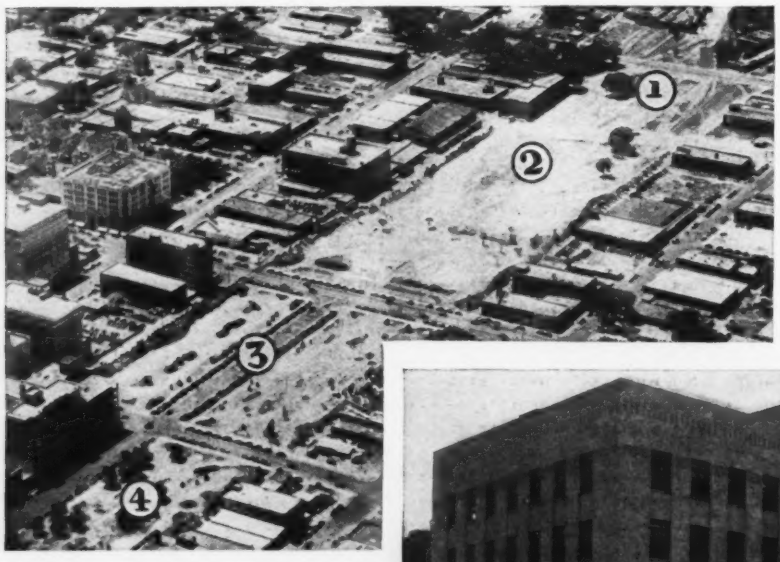


Fig. 1. Site of the Oklahoma City civic center before construction was started. The location of the buildings: (1) police headquarters; (2) auditorium; (3) city hall; (4) county building.

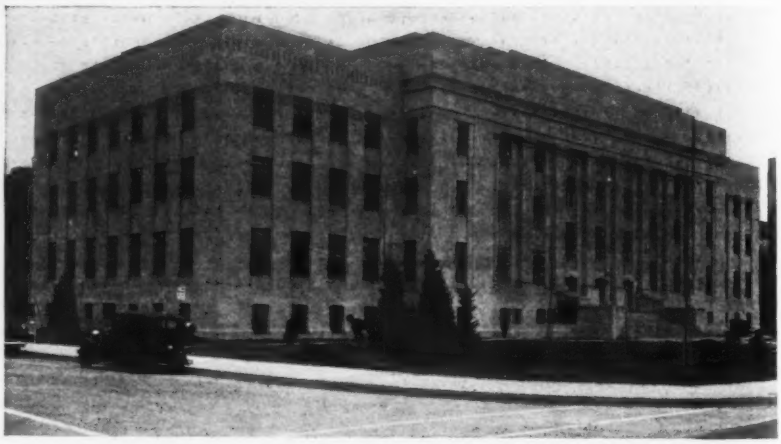


Fig. 2. City hall, recently completed, shows the type of architecture chosen for the civic center development.

FIG. 1. MODEL BUILT TO ONE-EIGHTH SCALE FOR TESTING HIGHWAY VISIBILITY UNDER VARIOUS CONDITIONS.

Road Lighting in the Laboratory

by DEAN M. WARREN

Nela Park Engineering Department, General Electric Co., Cleveland, Ohio

Lighting tests of a road model, checked later by actual road tests, show how to place and space lights for greater driving safety

BY AND LARGE the road engineer approaches the problem of highway lighting with a substantial volume of fundamental information provided by research. Street lighting has been a long debated subject; it has received the attention of illuminating engineers for many years, and their published determinations have been formulated into a code of practice that is widely followed. Withal, however, when recently rural highway lighting became a problem for imminent consideration it was found that the actual values of many factors were unknown. Research to supply the needed information was promptly undertaken by various agencies, among which was the Nela Park Engineering Department of the General Electric Co., at Cleveland, Ohio. Its procedure and results are summarized in the present article. They show how many of the elements in the present lighting installations described in the preceding article by R. M. Sweetland and T. W. Dana (*ENR*, Aug. 19, p. 312) were determined.

The laboratory work given particular consideration here includes studies of visibility, glare and spectral quality by means of a laboratory model and a determination of visibility on actual lighted highways. Previous experiments had prompted these later studies. More than a dozen years ago the Nela Park engineers in collaboration with the Cleveland Electric Illuminating Co. and the city of Cleveland built the ½-mi. outdoor street-lighting laboratory long known as Forty Streets in One. This lighted street was of great value in bringing into closer agreement the very widely divergent views then held by street-lighting authorities, but its greater value perhaps was that it demonstrated the impossibility of making comprehensive controlled studies of lighting on an actual roadway.

Even with 40 different lighting systems, the experimenter was narrowly restricted as to light output, spectral quality and distribution, spacing, height, arrangement and transverse position of the light sources. And of course there was no flexibility at all as regards street width. The pavement reflection characteristics changed only when it rained. The moon, often a welcome aid to the night driver, vied with extraneous sources of light and curious pedestrians in preventing measured observations. These facts are important to remember in making the natural assumption that the ideal laboratory is the actual lighted road. On the other hand experience in this country and abroad has shown that miniature road models are of limited usefulness.

Solving the test problem

The problem was to devise ways and means of avoiding the disadvantages of both the open road and the miniature model as an agency for carrying out the planned observations. As stated, there were important points in connection with street and highway lighting about which something was known but not enough definite fact.

For instance, the new vapor light sources that emit light of widely different colors brought with them the question of the relative value of light of different spectral qualities for the seeing job one has to do when driv-

ing a car along the highway. In addition, there was the question of glare from the lighting equipment, long recognized as an annoyance factor which also interfered with seeing. But just how serious was that interference, how much additional light should be provided to compensate for

Fig. 2. Visibility on a lighted road can be measured with a Luckiesh visibility meter and a telephotometer.

it and what percentage of the original illumination is wasted in the different systems, were questions which required answering. Also, there was the question of just how the light should be distributed to secure maximum effectiveness at the lowest cost.

The road model

Accordingly, when it was decided to undertake studies on the fundamentals of highway lighting, Kirk M. Reid and H. J. Chanon, street and highway lighting specialists of the Nela Park Engineering Department, decided to build a laboratory highway to one-eighth scale. This model, it was believed, would be of sufficient size to give the observer the impression of an actual highway and would also provide the flexibility and control so necessary for detailed study. Then too, observations on the model could be made at any time during the day or night irrespective of weather conditions and other extraneous factors.

The model constructed was 250 ft. long, which was the equivalent of 2,000 ft. of highway. It represented a highway with 30-ft. pavement, properly crowned and with 8 ft. berms (in the model, 45-in. width, 12-in. berms), which made possible studies with two- and three-lane pavements. Interchangeable pavement surfaces were provided, simulating asphalt, concrete and brick, and each having different reflecting characteristics.

The position of the lighting units was such that they could be varied over a wide range. It was possible to mount them at any height up to 40 ft. above the pavement, and with transverse positions anywhere from the curb to the center of the street. Spacings of 125, 250, and 500 ft., with staggered or one-side arrangement could be made.

The highway was equipped with actual mercury-vapor, sodium-vapor and incandescent lamps to permit study of the effect of spectral quality upon visibility. The lamp housings were so constructed that any one of the three sources could be rotated into the lighting position while the light from the other lamp, if burning, was screened from the street by means of baffles within the units.

Variations in the light distribution and major variations in the quantity of light that was emitted by the units were obtained by changing the size and shape of the apertures fitted over the light openings. It was also found possible to duplicate satisfactorily the light distribution given by present representative equipments, and to produce other distributions which appeared to give more favorable results.

The incandescent lamps were especially designed for this installation. They were three-filament lamps in tubular bulbs with a coating that diffused the light. The reason for employing three-filament lamps was to insure flexibility in quantity of light without materially changing the spectral quality.

The filaments of the incandescent lamps were controlled independently, and apparatus was provided for instantaneous switching from the vapor lamps to the incandescent lamps. The rotor shafts of the luminaires were connected in tandem by a flexible steel tape which made contact with a wide-surfaced pulley. A single turn of the pulley changed the lighting system from incandescent to gaseous or to a different type of light distribution or a different degree of shielding. Provision was also made to raise and lower various test obstacles and to move transversely to the street such objects as models of dogs, pedestrians or cars.

What the studies revealed

The results of some thousands of tests by many different observers using the model may be summarized briefly as follows:

1. With equal amount of light similarly distributed from sodium-vapor, mercury-vapor and incandescent sources, one sees objects of interest just as far away and just as soon with one kind of light as with the other. There is no difference in the ability to detect the presence of an obstacle or to discriminate between hazards.

2. With a light distribution representative of typical highway-lighting practice employing exposed light sources, the glare from the equipment was found to waste as much as 50 per cent of the illumination. This loss in seeing value is much greater than is generally recognized, and is in addition to the discomfort and distracting influence which is created by glare.

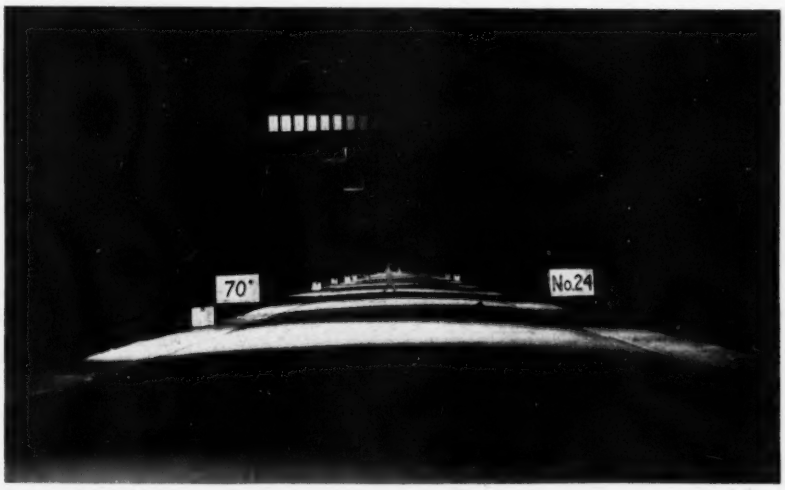
3. A highway with practically uniform horizontal illumination may present a large variation in brightness when viewed by driver or pedestrian. For uniform brightness the light must be distributed to avoid direct reflection of light at small angles from the surface, which is pronounced even in the case of the more matte pavements. This requires a more exact control of the light than is obtainable with past types of highway-lighting equipment. Light striking the pavement in a direction away from the observer is of little value in building pavement brightness. It is the light coming to the pavement and reflected toward a person that is effective.

4. Using the standard pole spacing of 125 ft. it is feasible to obtain this high order of brightness uniformity economically and at the same time to shield the sources sufficiently to obviate loss from glare to a very large extent.

5. Objects appear darker than their background at more than 80 per cent of the locations on the roadway. It is therefore desirable so to light the pavement that all parts of it appear substantially uniformly bright when viewed from the position of driver or pedestrian. A light-colored matte-surface pavement offers the best visibility and safety by night, whether the illumination is provided by fixed highway lighting or by automobile headlights.

Equally important with these formal conclusions was the development of a technique of evaluating the various lighting conditions in terms of seeing and, therefore, of safety. The visibility meter recently developed by M. Luckiesh and Frank Moss of the Lighting Research Laboratory at Nela Park was of particular value in this connection. This visibility meter, operating by the interposition of a film of graduated density, permits quantitative measurements of the visibility of obstacles at distances and positions on the roadway significant from the standpoint of safety. The same technique gives, for the first time, a means for measuring the seeing tasks and the seeing ability on actual highways under the great range of conditions to be met.

With experience with the road model as a guide observations were undertaken on actual lighted highways. The findings on the open road



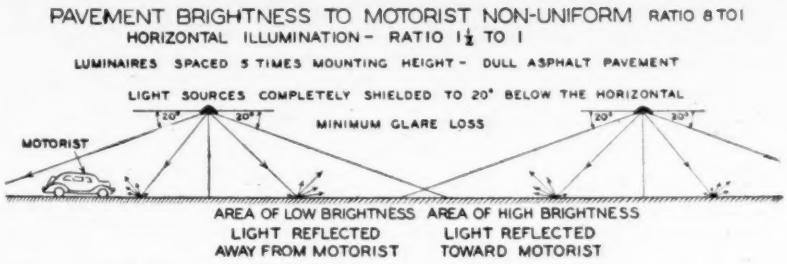

PAVEMENT BRIGHTNESS TO MOTORIST NON-UNIFORM RATIO 8 TO 1
HORIZONTAL ILLUMINATION - RATIO 1½ TO 1
LUMINAIRES SPACED 5 TIMES MOUNTING HEIGHT - DULL ASPHALT PAVEMENT
LIGHT SOURCES COMPLETELY SHIELDED TO 20° BELOW THE HORIZONTAL
20°
30°
MINIMUM GLARE LOSS
MOTORIST
AREA OF LOW BRIGHTNESS
LIGHT REFLECTED AWAY FROM MOTORIST
AREA OF HIGH BRIGHTNESS
LIGHT REFLECTED TOWARD MOTORIST

Fig. 3. With light shielded to 20 deg. of angle below the horizontal, the pavement is alternately bright and dark.

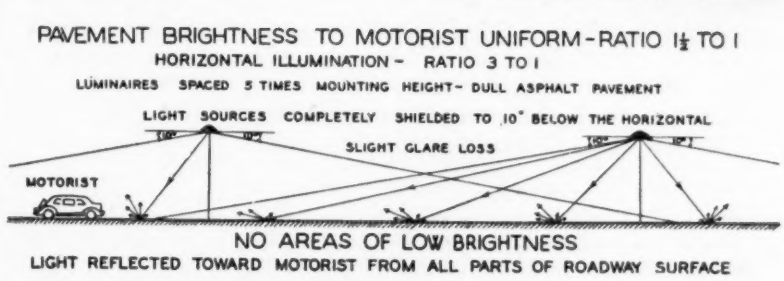

PAVEMENT BRIGHTNESS TO MOTORIST UNIFORM - RATIO 1½ TO 1
HORIZONTAL ILLUMINATION - RATIO 3 TO 1
LUMINAIRES SPACED 5 TIMES MOUNTING HEIGHT - DULL ASPHALT PAVEMENT
LIGHT SOURCES COMPLETELY SHIELDED TO 10° BELOW THE HORIZONTAL
10°
SLIGHT GLARE LOSS
MOTORIST
NO AREAS OF LOW BRIGHTNESS
LIGHT REFLECTED TOWARD MOTORIST FROM ALL PARTS OF ROADWAY SURFACE

Fig. 4. With light shielded to 10 deg. of angle below the horizontal, the pavement is uniformly lighted.

corroborated the data obtained from the studies on the highway model. Briefly, a form of the Luckiesh-Moss visibility meter adapted for observations on streets and highways was used from a motor car in measuring the visibility of test obstacles on and near the pavement. Measurements of pavement brightness and obstacle brightness were also made from within the car, using a telephotometer with a restricted field.

Editors' conclusion

Research has provided the fundamental principles for securing night visibility on highways by lights. As stated by S. G. Hibben (*ENR*, Aug. 5, p. 217) in the opening discussion and shown by R. M. Swetland and T. W. Dana in describing (*ENR*, Aug. 19, p. 312) some two score existing installations, the lighting engineer has only to adapt these principles with proper selectiveness to the local conditions. How this may be done is the question answered in an article by L. A. S. Wood to be published Sept. 23.

Earth Core Cheapens Rock Breakwater

by Morris W. Gilland

Captain Corps of Engineers, U. S. Engineer Office, Los Angeles, Calif.

Dredge-built fill covered with stone reduces cost of Los Angeles outer-harbor breakwater originally designed as an all-stone fill

A detached breakwater now being constructed as a protection for Los Angeles and Long Beach outer harbors, consists of an earth core enveloped and armored by a rock fill. Altogether the harbor improvement includes the construction of the detached breakwater 12,500 ft. long, and three dredging jobs, to provide (1) an entrance channel 1,000 ft. wide and 40 ft. deep to the outer Los Angeles harbor, (2) a turning basin 3,500 ft. long, 1,500 ft. wide and 40 ft. deep and (3) enlargement of the entrance to the inner harbor by dredging to a depth of 35 ft. a triangular area at the junction of the entrance channel and the turning basin.

Preliminary borings indicated that the materials to be dredged consist of sand and indurated sandy clay. In some places the clay verges on incipient shale and contains solidified concretions of shale. A small amount of silt overlies portions not recently dredged. In addition to the borings, laboratory experiments were made which indicated the feasibility of utilizing the dredged materials as a core for the detached breakwater and a plan was developed to do this since it offered a possible reduction in cost.

The average depth of water along the axis of the breakwater is 50 ft. To test the plan an experimental mound, 900 ft. long, was constructed by contract (April to July, 1932) to heights varying from 35 to 22 ft., referred to mean lower low water. Sand was placed first and covered with a blanket of clay, the proportions of sand to clay being varied in different parts of this experimental mound.

Based on results of experiments with this mound, the cross section shown in Fig. 1A was used in the second and third contracts, respectively, for constructing an additional 900 ft. of sand-clay core (October 1932 to January 1933) and for enrocking 1,413 ft. of the 1800-ft.

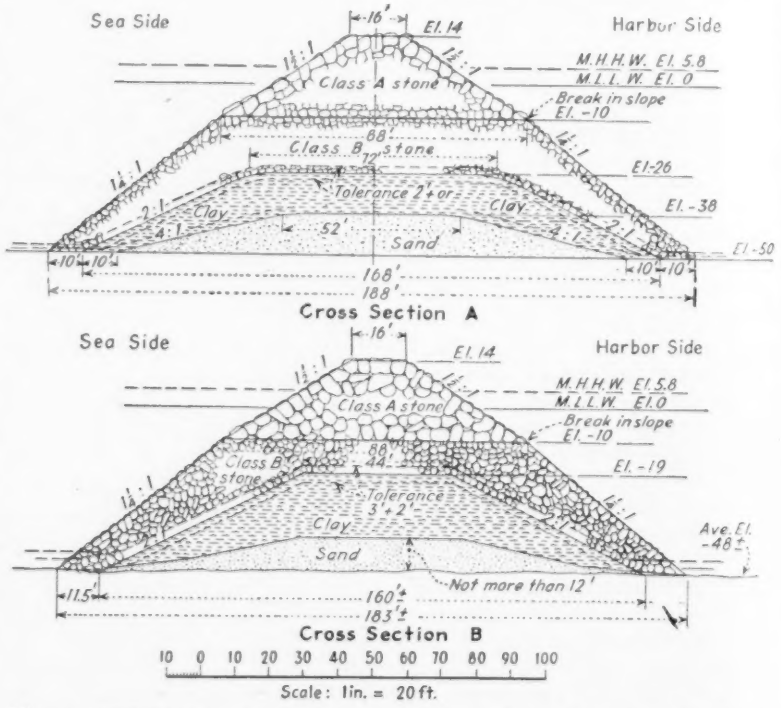


Fig. 1. ORIGINAL and modified cross-sections of composite type breakwater. Type A was so successful that type B was adopted for a latter part of the project.

Fig. 2. A WHIRLER type floating derrick has been the most successful means of placing the heavy topping stone for the Los Angeles breakwater.

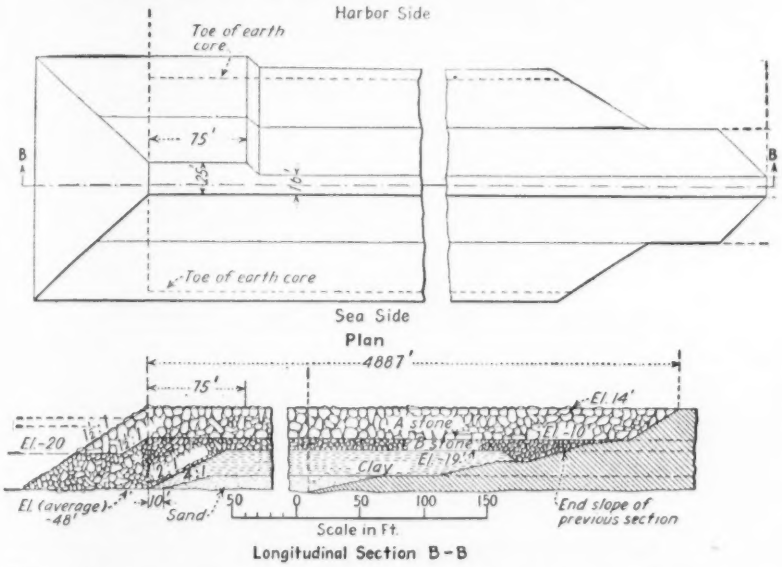


Fig. 3. Plan and section showing relations of core and stone at terminal of the detached breakwater.

mound then in place (March 1933 to July 1934). Two subsequent contracts (the latter of which was completed in July, 1936) added lengths of 4,000 ft. and 2,200 ft. respectively. These two later contracts included dredging, core construction and enrockment following the design shown in Fig. 1A.

No indication of failure or deterioration has appeared in the work completed and an average of only 18 in. of settlement has been observed. Accordingly, when it came time to add the remaining 4,887 ft. to complete the detached breakwater, the cross-section was modified to that shown in Fig. 1B. The modified section differs from the previous design in the respect that the upper limit of the sand and clay core has been raised from —26 to —19. This part of the breakwater, completing the detached portion, is now under construction. The progressively constructed extensions, contractors, quantities of materials, and prices bid are shown in the table.

Materials and payments

The sand and clay placed in the core are selected from materials obtained from the dredging area. The rock covering consists of two classes of stone: Class *B*, quarry run of which not more than 25 per cent by weight may be in pieces of less than 20 lb., and not less than 40 per cent by weight shall be in pieces of 1 ton or more each; class *A*, selected quarry stone, in which no piece shall weigh less than 1 ton, and at least 50 per cent by weight shall be in pieces each weighing 10 tons or more. These requirements cover stone furnished for the current contract; they modify former requirements by slightly easing the minimum sizes in view of the apparent stability of completed portions of the structure.

Payment for dredging and core material is made on the basis of measurements at specified depths in the dredging ground with 2 feet allowable over-depth and side slopes not flatter than 1 on 2. If the material dredged is considered unsuitable for use in the core of the breakwater, it is dumped at sea. Deductions are made from dredging estimates for deficiencies below or excesses above the tolerance lines in placing the dredged material in the breakwater core. Payment for enrockment is made on the basis of net quantities of stone, furnished and placed in the breakwater; the units of measurement are: for class *A*, the ton, and for class *B*, the solid cubic yard, exclusive of voids. Payment for class *B* stone by the solid cubic yard has resulted in a somewhat intangible saving to the government because the stone furnished invariably has been considerably heavier than the minimum specified weight.

Equipment and methods

Dredging is done with a large clamshell dredge of the California type with an 8 cu.yd. bucket. The dredged material is placed in bottom-dump scows, towed to the site of the breakwater and dumped while the scows are held in position by the tug and by lines attached to anchored floating moorings. Most of the stone is brought by barge from quarries on Catalina Island, about 20 miles seaward from the site of the breakwater, but some of the class *A* stone has been brought by rail from quarries at Riverside, some 60 miles inland and transferred to barges in Long Beach harbor. Some side-dump barges are used, but most of those used are of the bottom-dump type.

PROGRESS, QUANTITIES AND COSTS ON THE BREAKWATER FOR LOS ANGELES — LONG BEACH OUTER HARBOR

	1st Contract	2nd Contract	3rd Contract	4th Contract	5th Contract	6th Contract (current)	Total and Averages
Contractor	Standard Dredging Co.	Standard Dredging Co.	Puget Sound Br. & Dr. Co.	Rohl-Connolly Company	Rohl-Connolly Company	Rohl-Connolly Company	
Sub-contractor	.....	.....	.....	Standard Dr. Company Merritt-Chapman & Scott Co.	Standard Dredging Co.	Standard Dredging Co. Merritt-Chapman & Scott Co.	
Length (feet)	900	900	1,413	4,000	2,200	4,887	
Date commenced	Apr., 1932	Oct., 1932	Mar., 1933	Nov., 1933	Aug., 1935	Aug. 1936	
Date completed	July, 1932	Jan., 1933	July, 1934	May, 1935	July, 1936	Nov., 1938	
Dredging (core)							
Cubic yards (place measure)	81,807	102,685	None	498,541	279,027	667,000*	1,629,060
Unit price (dollars)	0.539	0.593	.....	0.60	0.45	0.50	0.53
Class B stone							
Solid cu. yd	None	None	140,390	286,469	164,860	328,000*	919,719
Unit price (dollars)	.....	.....	2.11	2.20	2.60	2.60	2.40
Class A stone							
Tons	None	None	116,630	310,095	180,177	408,000*	1,014,902
Unit price (dollars)	.....	.....	2.07	1.80	2.1988	2.35	2.12

*Current contract, quantities estimated.

Class *B* stone is dumped; class *A* stone is placed by floating derrick as individual stones. The most successful floating derrick is the whirler type shown in Fig. 2.

The materials are placed successively in the following order: sand, clay, class *B* stone, class *A* stone. The core portion of each successive extension is started at the southwesterly end of the work (farthest from the completed portion) since this is the weather end and maximum lee is thus provided for the construction plant. Each of the four component materials is then placed in successive echelons toward the existing completed portion of the breakwater, which is diagrammed in Fig. 3.

Economy of composite type

At the time the original report on the project was submitted (1930) it was estimated that a detached breakwater built entirely of rock, with a sea slope of 1 on 1½ and a harbor slope of 1 on 1-1/3 would cost about $7,000,000. Now that five contracts on the composite type have been completed, including the estimated cost for finishing the present contract plus estimated costs for inspection and overhead, the total cost of the completed breakwater can be said to be about $5,566,000. This includes, as a part of the entire harbor project, about 1,629,060 cu.yd. of dredging in entrance channel and turning basin at a cost of $863,173. Allowing 15c. per cu.yd. for this, or $244,359 as the increased cost for dredging and placing in the breakwater core, as compared to dredging and wasting the dredged materials at sea, there remains a further credit to savings in the entire project cost of $618,814.

The cost of the composite design used as compared with the cost of an all-stone structure, involves intangible factors which cannot be evaluated accurately enough to permit a direct and exact comparison. Subsequent to the original estimates, other designs for an all-stone breakwater were submitted on which estimates were as low as $7,250,000. Dredging for navigation only might possibly have been accomplished by pipe line dredge, disposing of the material on the seaward slope of the San Pedro breakwater, at a cost lower than the actual.

However, because of the peculiar combination of circumstances in this locality, a substantial saving (more than $5,000,000, based on the original project estimates for an all-stone breakwater) has resulted in the execution of the entire harbor improvements projects by using a composite-type breakwater of dredgings which under normal procedure would have been wasted.

The work is being carried on under the U. S. Engineer Office, Los Angeles, California, Major Theodore Wyman, Jr., district engineer; H. W. McQuat, associate engineer, area engineer of the Fourth Field Area is in local charge. All experimentation and development of the composite type breakwater was under the immediate charge of D. E. Hughes, senior engineer, now retired.

• • •

Centralized Purchasing Saves Tax Money

BUSINESS METHODS are being applied more and more in handling the public affairs. Centralized purchasing, the "sentry at the tax exit gate," has been installed in more than 200 cities, 16 counties, 36 states and five provinces of Canada, figures furnished by the Municipal Finance Officers' Association show. It is estimated that New York City, Cincinnati and Milwaukee alone save about $10,000,000 a year through their central purchasing plan.

Thirty or forty per cent of every tax dollar is spent for commodities, and centralized purchasing under competent non-political personnel is regarded as a definite means to conserve these expenditures.

Statistics gathered throughout the country prove that an average saving of 15 per cent is achieved through efficient operation of a central purchasing department.

Dr. Russell Forbes, commissioner of purchases, New York City, defines centralized purchasing as "the delegation to one office of the authority to buy supplies, materials and equipment needed by all the operating branches of an organization." He also says: "The essential business of municipal purchasing consists of furnishing exactly the right product at the time it is needed, at the best price." New York City, before centralized purchasing spent about $25,000,000 a year for supplies under the budget alone, exclusive of open market orders and expenditures for supplies, materials and equipment under corporate stock appropriations for public improvements, which hit about $25,000,000 more. Fifteen per cent meant a big saving there.

Milwaukee's central board of purchasing, during 1936, handled about $3,000,000 in supplies, materials, equipment and minor services. Savings there, too, average 15 per cent and deliveries are speeded. Cincinnati's department of purchasing handled $5,605,550 worth of business in 1936, encompassing 13,247 purchase orders, and entailing 309 contracts.

Grand Coulee Cofferdam Removal

With danger of summer floods past, progress on remaining work is definitely scheduled

REMOVAL of upper portions of the cofferdam now under way at Grand Coulee dam indicate that the fight with the river is over and for the remainder of the job attention will be concentrated on pouring concrete, constructing control works and, in general, building on the concrete foundation that has been placed on the granite bedrock of the river channel. On Aug. 19 the M.W.A.K. contract was 83 per cent completed with only 65 per cent of the time elapsed; this corresponds to about fifteen months ahead of schedule. Meantime, work on specifications for the completion of the high dam and power houses is under way in the U. S. Bureau of Reclamation and the expectation is that bids on the first part of this work will be called for in late October or early November.

Maximum flow in the Columbia River at Grand Coulee Dam this year occurred June 25 with water surface at El. 965.7 and a flow of 273,400 sec.-ft.—a quantity considerably below last year's maximum. The river elevation on Aug. 19 had dropped to 944.8 and the flow to 108,000 sec.-ft. Before the summer flood the contractor had built the cofferdam crest to El. 990 ft. (upstream) and was prepared to handle a maximum flood of 550,000 sec.-ft.

Removal of the upper portions of the cofferdam arms to bring the tops down to El. 965 upstream and 960 downstream now is under way. Steel piling has been cut off to these elevations and fill has been removed from the shore to the concrete in spillway sections of blocks 39 and 40 on both upstream and downstream arms. Removal of the fill in the circular cells has been accomplished principally by bulldozing the material through large square openings cut in the steel piling on the river side of the cells and by power shovels working in the timber cribs and on the fills at the shore ends. The 9,000,000, ft. b.m. of timber used in the cribs is not being salvaged; the cribs are dynamited where this is convenient, and timber wreckage is burned in large pyres.

Excavation totals

All excavation has ben completed at the site except about 75,000 cu.yd. in the east abutment and some 60,000 cu.yd. to be taken out later at the pumping plant site. Almost all bedrock had been covered with concrete by Aug. 19 including most of the low-level concrete in the east powerhouse structure. Cooling was under way on the east side throughout the recently placed concrete; cooling has been completed in the concrete on the west side of the dam.

Common excavation on the project to date exceeds 21,500,000 cu.yd. and rock excavation totals somewhat more than 1,500,000 cu.yd.

By mid-August the quantity of concrete in Grand Coulee dam had equaled the total amount in Boulder dam and the really high rates of pouring were only just beginning. The best day's pour at the time had been 14,000 cu.yd., but higher rates of placement are expected. The present cement consumption is about 60 carloads per day.

Information in the foregoing was obtained from the U. S. Bureau of Reclamation, for whom the dam is being constructed by the Mason-Walsh-Atkinson-Kier Co.

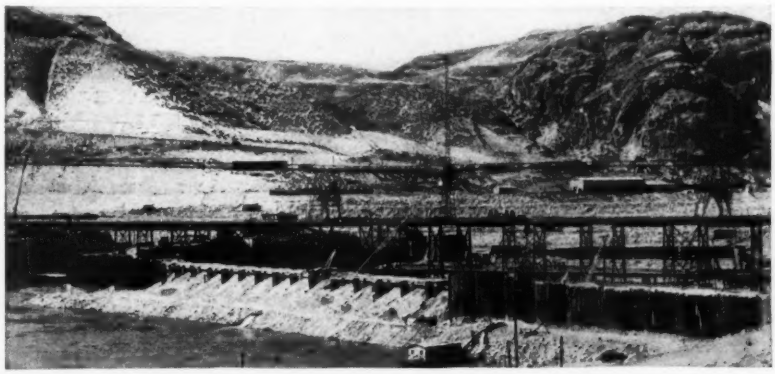


Fig. 1. Upstream arm of east cofferdam at Grand Coulee in process of demolition. Note remnants of timber cribs at left.

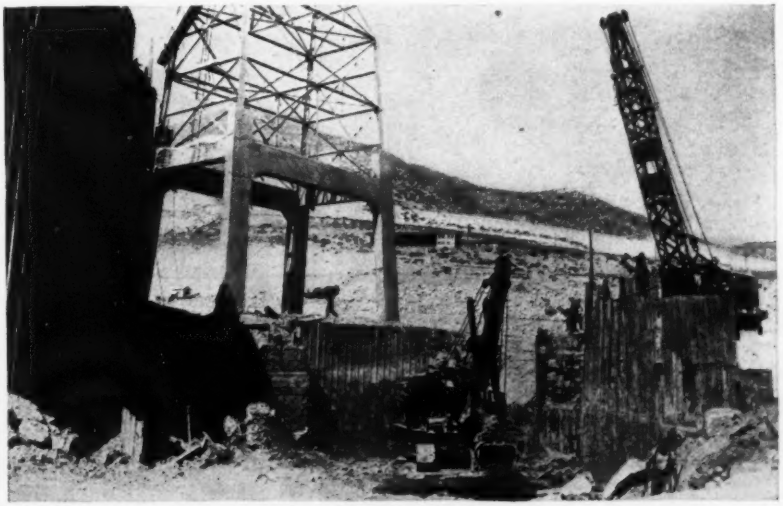


Fig. 2. Steel sheeting is pulled by cranes and timber cribs uprooted by power shovels in demolishing Grand Coulee cofferdam.

Stress Paths and Economical Framing

by George Booss, Jr.

Assistant Engineer (Designer), Board of Water Supply, New York City

Studies of alternative framing layouts to minimize distance stress must travel to reach a support often pay dividends in reduced steel tonnage

Whenever a floor is to be constructed or a bridge built the question of the location and direction of the main carrying members arises. Naturally, the most economical type of framing is desired. A proper approach to the problem is to determine the minimum theoretical quantity of steel required to transmit the loads to the supports, disregarding such variable practical considerations as esthetics, advantage of one type as regards underclearance, special advantages due to specification requirements for minimum web thicknesses, etc. In such studies the author has found the use of "stress paths" very useful.

Consider the framing required by the situation shown in Fig. 1 where it is desired to carry a street 80 ft. wide over a railroad or highway underpass 60 ft. wide. Assuming that the same reinforced concrete roadway slab will be used for all the designs, a choice must be made between several types of steel supporting structure, two of which are shown. What is the effect of the combined live and dead load on any given element of area ΔA located at the same place in each type?

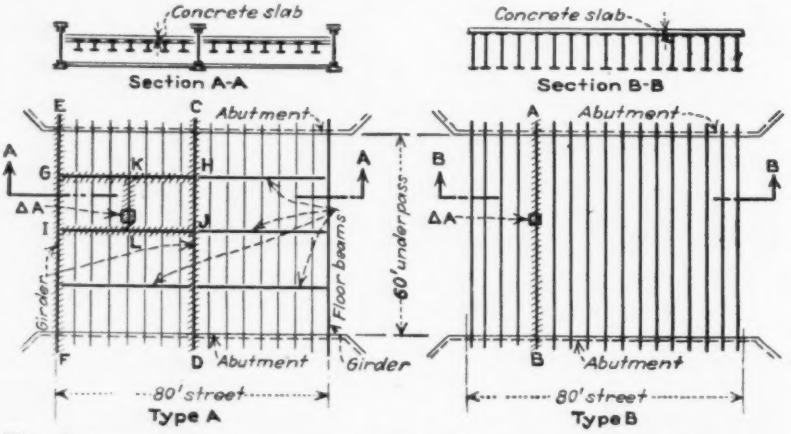


Fig. 1. Two methods of framing a bridge deck. The stress path for loads on area ΔA in Type B is much shorter than in Type A. Stress paths are shown hatched.

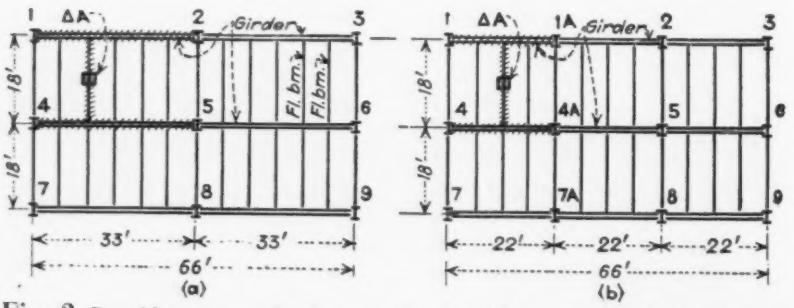


Fig. 2. By adding a row of columns to framing (a) the stress path is shortened as shown in framing (b); since girder steel is reduced while column steel is not increased, economy results.

In the type A structure the load on area ΔA in reaching its final support at the abutment causes bending moments and shears in stringer *KL*, floorbeams *GH* and *IJ*, and girders *EF* and *CD*. In type *B*, however, the stress path is direct, and moments and shears are caused only in girder *AB*. If we assume that the girder depths are the most economical ones in each case, it is apparent that the metal required to transmit the load in bending to the abutment via girder *AB* is approximately the same as that required in girders *EF* and *CD* combined. In Type A, however, stringer *KL* and floorbeams *GH* and *IJ* are also affected by the loads. This added length of stress path represents a greater material requirement for Type A and would indicate that Type B is the more economical.

From the above example we may generalize and say: All other things being equal, that type of framing is most economical in which elementary units loads are conducted most directly to their ultimate support, or in other words that type in which the stress path is the shortest.

This principle of minimizing the length of stress path is of course only common sense, but the writer has not previously encountered it in print. Appreciation of its importance should assist engineers in intelligently selecting a framing system and give rational basis to what is many times a mere instinctive feeling.

How many columns?

This same type of analysis may be used to study the effect of introducing another row of columns in a given floor framing system such as

is shown in Fig. 2a. The stress path of an elementary load area ΔA, selected at random, is indicated by the members cross-hatched. In Fig. 2b another row of columns has been introduced and the girder lengths reduced from 33 ft. to 22 ft. The sketch clearly shows that while an equal length of beam is subject to bending, the length of girder affected in transmitting ΔA to the columns is reduced by one-third. Another interesting point is that, neglecting possible minimum sizes of column sections, no additional material is required in the columns as a whole despite their increase in number since the total vertical floor load remains the same.

The framing shown in Fig. 2b not only reduces the length of girders transmitting the load from ΔA but, by decreasing the span, it also reduces the magnitude of the bending moments throughout, and hence less metal is required per unit length of girder.

Weighted length of stress path

In considering more complicated types of framing, where the load on area ΔA travels through several members in reaching its ultimate support, it is necessary to introduce the conception of the "weighted" length of stress path. Such necessity is indicated by the fact that more metal per foot of beam is required to transmit a central load on a 60-ft. span than on a 30 ft. span; similarly, a load at the center of a beam requires more metal per foot for its support than the same load at the quarter point. In the case of beams and girders for practically all types of loading, the center moment is the determining design factor. Generally when it is satisfied, the member is strong enough in shear.

A little reflection on the flange-area method of proportioning girders (or beams) leads to the conclusion that the resisting moment of any beam or girder is directly proportional to the area of the flange and to the effective depth. Since the area of the flange constitutes the bulk of the weight of the girder, the resisting moment is proportional to the weight per lineal foot of the girder. We thus establish the principle that the weight per lineal foot of stress path is directly proportional to the center moment induced and inversely to the depth of the beam or girder.

In Fig. 3 is shown the framing plan of a viaduct recently erected in New York City, and in Fig. 3b an alternate design. Superficially, Fig. 3b should be the more economical as the stress transmission to the columns is more direct, and the doubling back of the stress path upon itself as in Fig. 3a is avoided. However, it is possible to determine the most economical layout accurately by evaluating the weighted length of stress path in both designs for a few typical load areas, ΔA, ΔB, ΔC, etc., assumed equal to unity. The fractions on Fig. 3a indicate the portions of the unit load, ΔA traveling via the various paths to their ultimate support at the columns. The center moment in any beam or girder shown is obviously equal to the smallest reaction on that beam multiplied by one-half the span length. The computations are given in the accompanying table.

The table shows a considerably shorter weighted length of stress path for load ΔA in framing Fig. 3b. A similar computation for area ΔB shows the weighted lengths of stress

DETERMINING WEIGHTED LENGTH OF STRESS PATH FOR UNIT LOAD ON △ A

Member (1)	Center Moment (2)	Reciprocal of depth (3)	Relative wt. p.l.f. of member (2x3) (4)	Length of member (5)	Weighted Length of member (6)
For Design Fig. 3a					
AB	½ x 15	1/24	0.313	30	9.39
CD	1/8 x 30	1/48	0.078	60	4.68
HJ	1/8 x 30	1/48	0.078	60	4.68
CE	3/16 x 30	1/72	0.078	60	4.68
DF	1/16 x 30	1/72	0.026	60	1.56
			Total = Weighted length of stress path =		24.99
For Design Fig. 3b					
AG	1/4 x 30	1/48	0.156	60	9.38
CD	3/16 x 30	1/72	0.078	60	4.68
EF	1/16 x 30	1/72	0.026	60	1.56
			Total = Weighted length of stress path =		15.62

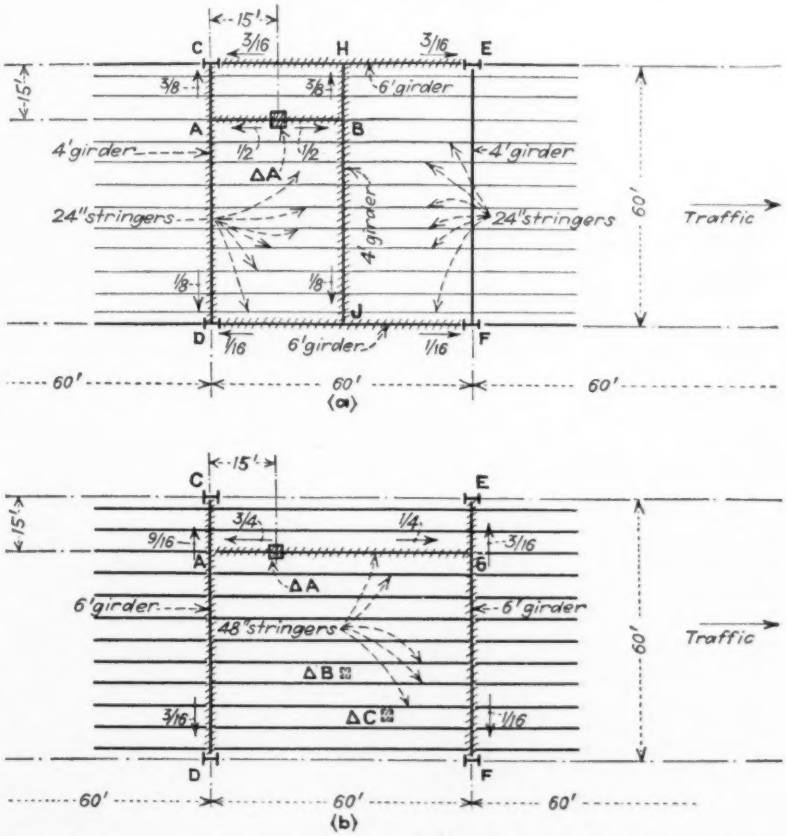


Fig. 3. Comparison of viaduct framing as built (a) with an alternative design (b) giving shorter stress paths and a resultant 20 per cent saving in steel tonnage.

path to be equal, while ΔC again has a shorter length of weighted stress path for the design of Fig. 3b. It would appear that a design along the lines indicated by Fig. 3b would be the most economical, and, in fact, a complete comparative design based on this type of framing shows a saving of more than 20 per cent compared to the structure as erected. We can only assume that factors other than simple economy influenced the choice of such an indirect framing system.

Framing a foundation opening

Another example of this type of analysis is illustrated in Fig. 4, where a foundation wall *MNOP*, 35x100 ft. in plan, is to be used for the support of a floor to carry a total load of 200 lb. per sq.ft. Assuming that no interior columns are to be permitted and that a concrete slab of given thickness is to be used, nine out of ten engineers would tentatively suggest the type of framing shown in Fig. 4b. Considering the matter, however, from the standpoint of the available stress path between the supports and several load areas, the economy of this framing is seen to be questionable. For such areas as ΔA and ΔC the shortest stress path to a support is transversely to *MN* and *PO* via the beams shown in Fig. 4b, but it is obviously uneconomical to transmit loads on such areas as ΔB and ΔD transversely when support is available much nearer in *MP* and *NO*. The type of framing shown in Fig 4c, therefore, suggests itself, and comparative designs using standard rolled sections show that an 8 per cent saving in steel results.

It will be noted in Fig. 4c that the longitudinal framing is carried in 10 ft. from the end supports. A development of a generalized formula follows for the location of this cut-off point at which, in a loaded rectangular area supported around its perimeter by a continuous foundation or by columns, it becomes advantageous to frame in a longitudinal direction. Such a problem continually presents itself in practice, and an expression for the most economical proportion of L to W, see Fig. 5, should be of great value to engineers and architects.

The general procedure to be followed will be to set up an expression for the total weight involved in transmitting the load area $A \times W$ to the supports. This expression will involve the terms W, A and L (see Fig. 5) and, by differentiating with respect to L, we may determine the value of L for a minimum weight of framing. The depths of the different beams are not known but we may assume that they will have depths proportional to their spans, a condition closely approximated in the usual rolled-beam floor construction. Thus the depth of the longitudinal beams will be in the ratio L/W to the depth of the transverse beams.

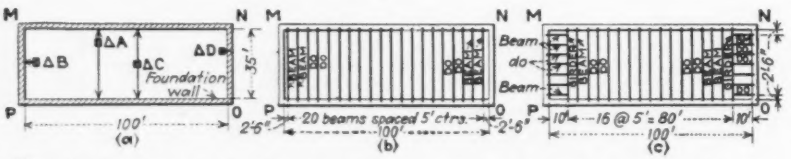


Fig. 4. By changing the direction of beams near end of framing (b) as shown in framing (c), stress paths for loads on ΔB and ΔD are shortened.

The area $A \times W$ naturally divides itself into two portions, *MQRO* and *QNPR*. Considering first the portion *MQRO* we find that a total center moment $WL \times L/8$ is induced in the longitudinal beams and to determine the weighted length of beams we must multiply this by the length L and the inverse ratio of depth W/L, giving the weighted length of longitudinal beams $= WL \times L/8 \times L \times W/L = W^2L^2/8$. The header beam *QR* receives from the longitudinal beams an approximately uniform load equal to $\frac{1}{2}\ WL$, the center moment is $\frac{1}{2}\ WL \times W/8$, the depth ratio unity, and the length W. Hence the weighted length of *QR* (functioning as a part of system *MQRO*) equals $\frac{1}{2}\ WL \times W/8 \times 1 \times W = W^3L/16$.

The moment induced in a transverse direction by the area *QNPR* equals $W(A-L) \times W/8$. The depth ratio is again unity and the length of beams is W. The weighted length of transverse beams therefore equals $W(A-L) \times W/8 \times 1 \times W = W^3/8 \times (A-L)$.

The total weight of steel Y in the area $A \times W$ equals the weighted length of the longitudinal beams, plus the weighted length of header *QR*, plus the weighted length of the transverse beams.

$$Y = \frac{W^2L^2}{8} + \frac{W^3L}{16} + \frac{W^3(A-L)}{8}$$

$$= \frac{W^2L^2}{8} - \frac{W^3L}{16} + \frac{W^3A}{8}$$

Differentiating with respect to L and equating to zero.

$$\frac{dY}{dL} = \frac{2W^2L}{8} - \frac{W^3}{16} = 0$$

Solving for L for a minimum of weight Y,

$L = 0.25W$

We may in consequence state that the ratio of span of longitudinal to transverse framing in a system with supports around the perimeter of the area should be 1:4 for maximum economy. This conclusion is predicated on the assumption that the depths of the beams are proportional to their span. In the event that the depths of longitudinal and transverse beams are equal, it can be shown by a derivation similar to that given above that the most economical framing obtains when $L = 0.41W$.

Actual computations using rolled H-sections with a loading of 400 lb. per sq.ft., $W = 50$ ft., $A = 125$ ft., and $L = 12.5$ ft. (beam depth proportional to span), showed a saving of 25.5 per cent for the type of framing illustrated in Fig. 4 over a simple transverse system.

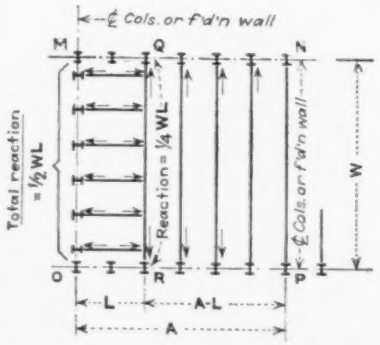


Fig. 5. Minimum steel is required when $L = 0.25\ W$, providing all beam depths are proportional to their spans. If all beams are same depth, L should equal $0.41\ W$.

THE WEEK'S EVENTS

Continued from page 375

Flood Planning To Continue

Compact failure will not stop New England flood-control planning

Failure of Congress to ratify the interstate compacts for flood control on the Merrimack and Connecticut Rivers prevents immediate progress on construction of the contemplated flood-control dams but will not stop the progress of planning and design work, according to statements of the War Department. Funds for continuing investigations and design work are available, but no decision has yet been reached as to the rate at which the planning should continue in consideration of the necessary postponement of construction until the compacts are ratified.

The Merrimack River compact provides for the construction of two dams on principal tributaries of the river: a rolled fill dam on the Pemigewasset River above Franklin, and an earth dam on the Blackwater River at Webster. These dams form part of a series of reservoirs under study by the U. S. Engineer Office at Boston for control of Merrimack River floods in conjunction with local protection works at critical points including Fitchburg, Lowell and Haverhill. By the terms of the federal flood-control act the states are required to provide the necessary lands, easements, and rights-of-way, and the Merrimack River compact provides for payment by the states for these purposes in an amount not exceeding $2,285,000, including necessary relocations, the cost to be divided equally between Massachusetts and New Hampshire.

The Connecticut River compact, framed and ratified by New Hampshire, Vermont, Massachusetts and Connecticut, provides for the construction of eight reservoirs under similar conditions, the division of land and relocation cost to be in the ratio of 5, 5, 50 and 40 per cent respectively. As in the case of the Merrimack, these reservoirs are part of a system under study by the army engineers, in charge of the Providence engineer office. The four largest of the eight embraced by the compact are at Union Village on the Ompompanoosuc River, and at North Hartland on the Ottauquechee River in Vermont, with drainage areas of 126 and 222 sq. mi. respectively, at Surry Mountain on the Ashuelot River, drainage area 100 sq. mi., in New Hampshire, and at Knightsville on the Westfield River in Massachusetts, drainage area 164 sq. mi. Earth dams are planned for most of the sites.

Formation of the interstate flood-control commissions provided for by the compacts and the purchase of the reservoir sites by the states for the account of these commissions are expected to be deferred until Congress has ratified the compacts, and until then construction cannot begin.

In respect to the question that held up ratification of the New England compacts, the question of federal vs. state control of the works and their power, two points appear to be at issue: (1) the Federal Power Commission's desire to have jurisdiction over power even where small non-navigable rivers are involved, and (2) the President's belief that title to the damsites should vest in the federal government. The Flood Control Act, under whose terms the compacts were drawn, implies effective ownership and control by the states in its provision that the states shall maintain and operate the works without further defining or restricting this responsibility.

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Feather River Highway Opened in California

The 78-mile Feather River highway between Oroville and Quincy, Cal., was opened to traffic, to the accompaniment of dedication ceremonies, on Aug. 14. The $8,500,000 road is a link in a highway from Sacramento and other central California points to Reno.

The new highway is primarily of scenic interest, following the north fork of the Feather River through very rugged country and reaching an elevation of 3000 ft. However, it also opens the best route through the mountains connecting central California and Reno. The route of which it is a part crosses Beckwith Pass at an elevation of 5250 ft. where snowfall is relatively light, whereas alternative routes cross at elevations of 7150 and 7350, in regions of heavy snow.

Building of the highway involved excavation of 7,500,000 cu.yd. of rock and earth and the drilling of three tunnels, 265 ft., 390 ft., and 1,172 ft. in length.

School Rebuilding Program Begun by PWA Allotments

Repair and rebuilding of 350 schools with a total construction cost of $47,069,000 is made possible by PWA allotments of $22,296,000 announced last week. The allotments include outright grants of $21,269,000 and loans of $1,029,000. The allotments are the first to be approved under the 1937 act extending PWA for two more years.

Of the allotments, 291 were from the list of so-called fire-hazard school applications. Reference was given to applications calling for demolition of old school buildings. All applications for replacement of buildings burned down have been approved, but applications to meet an overcrowded condition or to remedy a fire hazard requiring only minor alteration were not approved.

The remaining 59 projects include schools classified as health hazards. Among the approved applications are those designed to overcome dangerous conditions by eliminating scattered unsanitary schools so that students may be concentrated in healthier surroundings. All allotments were based on a consideration of whether or not the community could finance the construction without federal aid.

Cleveland bridge project

Also announced last week was a grant of $2,205,000 to the board of county engineers of Cuyahoga county, Ohio, for the construction of a $5,556,000 bridge in Cleveland. The application for the bridge was filed before April, 1935 and the local contributions have been provided for by an election.

The bridge is of a high level type and is part of a highway development program which includes the construction of a new highway through the city of Cleveland running along the shore of Lake Erie.

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San Francisco Subway Vote Approved by Supervisors

The San Francisco board of supervisors on Aug. 17 approved an ordinance submitting to the voters a $25,000,000 rapid transit bond proposal. This proposal is to finance a double track rapid transit subway under Market St. which, with the station, connections, grades and so forth, is estimated to cost about $45,000,000.

The proposal has been the subject of much controversy, in the course of which the supervisors first rejected the idea of submitting the bond issue to the people at the November election. This aroused considerable protest, and the present decision reverses their previous stand.

Idaho's Sinking Canyon Is Land Slip

The so-called sinking canyon in Idaho, a land subsidence which in recent weeks has destroyed more than 100 acres of farm land and has aroused fears that the bed of the Salmon Falls River might sink and make the river go underground, has been declared by the Geological Survey, on the basis of reports and photographs received from its field office in Idaho, to be a "land slide of the gradual modified type known to geologists as a land slip." The Survey declared that its report refuted the original theory that a "sink" had developed.

The land slip, near Buhl, seems to be of an unusual but not unprecedented magnitude. Explaining the phenomenon, the Geological Survey report stated that the Salmon Falls River, a southern tributary of the Snake River, has cut a steep-walled canyon into the silty bed of the Snake River plain. The river undercuts the canyon walls from time to time and large masses of earth break away, some of them settling in the bottom of the canyon and others on the side. The blocks that break off are of various sizes and as they begin to break, cracks appear at the landward edge. In the case of large blocks, these cracks may sometimes be several hundred feet from the edge of the canyon. This appears to be the case in the phenomenon at Buhl. Movements of this kind may result directly from undercutting of the base of cliffs by streams or from irrigation which soaks the soil.

The Geological Survey recalled a similar occurrence in 1925 when a 15,000,000 cu.yd. mass of rock slid into the Gros Ventre River, damming the river and producing a lake several miles long. The dam partly gave way in 1927 and caused a flood in the Snake River, carrying away bridges and causing loss of seven lives.

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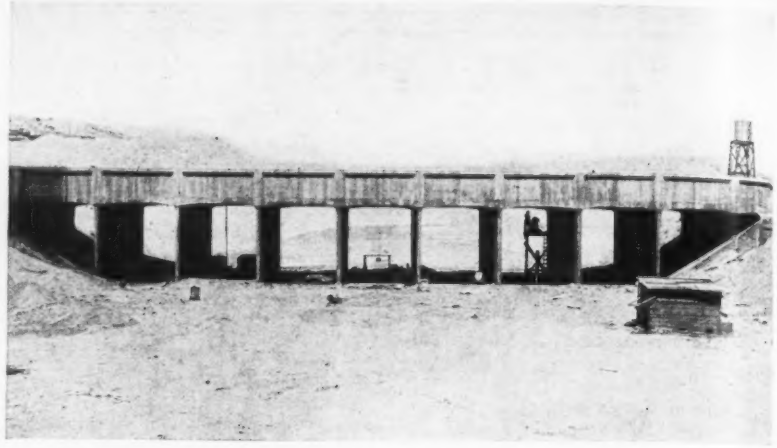
Sixteen Per Cent Diversion Found by Road Bureau

Nearly 16 per cent of the state taxes paid by highway users in 1936 was diverted to non-highway use, it was reported Aug. 18 by the U. S. Bureau of Public Roads on the basis of statistics collected from state authorities. The diversion of $169,344,000 from the more than a billion dollars collected in state highway taxes marked an increase of $22,202,000 over diversion in the previous year.

Of the undiverted money, $583,616,000 was for state highway purposes, $265,496,000 was for local roads and streets, $37,942,000 for administration, $1,597,000 for such highway purposes as park and forest roads, and $8,345,000 was undistributed.

Of the diverted highway funds, about $89,000,000 went to general state, county and municipal funds; $36,500,000 was paid for relief of unemployment; $33,000,000 was given to education; and about $11,000,000 was for miscellaneous purposes.



RIVER OVER CANAL

THIS is the overchute which carries Wash 888 across the All-American Canal, now under construction by the Bureau of Reclamation in Southern California. Wash 888 is usually dry, but during the infrequent storms which strike the desert country, it becomes a torrent in a few minutes. To protect the canal, therefore, it is necessary to provide a means to carry the waters of the wash across the canal to the Colorado River beyond. This structure shown is one of a series built to carry washes across the canal.

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All Options Are Obtained For Atchafalaya Outlet

Location of the new outlet for the Atchafalaya Basin will be through Wax Bayou and Wax Lake, the Corps of Engineers announces. It will involve the excavation of 55,000,000 cubic yards of material and will cost $5,000,000. All of the necessary land is under option.

Complaints that flowage options had been obtained in the Eudora floodway before some of the property owners clearly understood what was involved has led the president of the Mississippi River Commission to write to each person who has signed an option allowing ten days to cancel the agreement.

While there has been no announcement as to the number of options that have been secured in any of the Louisiana floodways it is known that only a small percentage of the property owners have been willing to sign the options. It is believed that the owners of seventy-five per cent of the property in the West Atchafalaya floodway will sign flowage options as this is the only way in which they can hope to secure compensation in the event the floodway is used.

Plan Infringement Charged On Ruby Dam Design

Lars Jorgensen, Berkeley, Cal., construction engineer and designer of Seattle's Diablo dam, has complained to the Seattle city council and board of public works that the plan of the Seattle city light department to use an arch type dam at Ruby Creek on the Skagit River hydro-electric project involves "piracy" of a constant angle arch dam designed by him.

Mr. Jorgensen declared that he recently drew plans for Lighting Superintendent Ross for an angle arch dam at Ruby and that Mr. Ross later informed him a gravity type dam had been adopted. He charged that the type of dam to be used at Ruby is, with some differences in detail, substantially the dam he had proposed.

Denying the charges, Mr. Ross said that although Ruby will be an arch dam it will be much heavier than that designed by Mr. Jorgensen.

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Municipal Bankruptcy Act

President Roosevelt on Aug. 17 approved the so-called municipal bankruptcy act permitting local taxing agencies, including municipalities and drainage, irrigation, sewer, levee, school, road, port and similar improvement districts, to reorganize under bankruptcy proceedings. The new bill requires the consent of the municipality before bankruptcy proceedings can be put under way.

OBITUARY

H. W. D. Armstrong, 85, a civil engineer and a charter member of the Engineering Institute of Canada, died recently in Toronto.

Thomas Clark, a civil engineer of New York City and graduate of Cornell University, died Aug. 21 in Evanston, Ill. at the age of 66.

Samuel Breck, formerly connected with the civil engineering staff of the Stone & Webster Engineering Corp. and the Aberthaw Construction Co. of Boston, died at Middleboro, Mass., Aug. 21, at the age of 47. Mr. Breck was a graduate in 1914 of the Massachusetts Institute of Technology.

Charles P. Woodworth, vice-president of the Weber Chimney Co. of Chicago, died Aug. 12 at the age of 56. Mr. Woodworth had been vice-president since 1909. A registered structural engineer, Mr. Woodworth specialized in the construction of reinforced concrete chimneys during his entire career. Due to ill health, he had not been active in business since 1934.

Frank Bogard, 56, dean of the school of engineering at Louisiana Polytechnic Institute, died Aug. 15 at Madisonville, Ky. Dean Bogard was a graduate of the University of Kentucky and taught for three years at Clemson College, Clemson, N. C., before joining the Louisiana Tech faculty in 1910. He had given up his active duties due to ill health since last February.

Stuart S. Oliver, a civil engineer and land surveyor of Quebec City, died there Aug. 17 at the age of 80. Mr. Oliver served for nearly 30 years on the engineering board of the old Quebec & Lake St. John Ry. and for part of that time also on the board of the Canadian Northern Railway, until, in 1910, he joined the Quebec Railway Light & Power Co., serving with that company for 20 years.

Thomas J. F. King, assistant district engineer, Quebec, for the Canadian National Railway, died Aug. 17 in Quebec at the age of 56. After his graduation from Glasgow Technical College, Mr. King practiced mining engineering in Scotland, coming to Canada in 1905. In Canada Mr. King had worked on the staff of Mond Nickel Co., the Canadian Pacific Ry., and finally the Canadian National Ry. at Moncton and then at Quebec.

Bernard A. Wood, until his retirement this month chief engineer of the Mobile & Ohio R.R. died in St. Louis at the age of 70. Mr. Wood had been in the service of the railroad for 40 years and had been chief engineer since 1910. Before coming with the Mobile & Ohio, he had been employed by the Louisville & Nashville R.R. and had also served an an engineer on the international boundary survey of the United States-Mexican border and was employed as an engineer by the Nicaragua Canal Board.

Albert M. Baker, 61, appointed last month as chief administrative assistant in the Southwestern Division of the U. S. Engineers at Little Rock, Ark., died Aug. 20 in Memphis, Tenn. Mr. Baker had been with the U. S. Engineers since 1899 and had been stationed in Memphis since 1923. There he was chief clerk of Districts 1 and 2 in the Mississippi River Commission until 1928 when he transferred to the Memphis district of the U. S. Engineers in an administrative capacity.

George Champe, 69, Toledo consulting engineer and senior member of the firm of Champe, Finkbeiner & Associates, died in Chicago Aug. 22. After his graduation from the University of Indiana in 1893, Mr. Champe served for some years as city engineer of Bloomington, Ind. entering private practice at Toledo in 1900. For some years he devoted his chief attention to interurban railway construction. He later specialized in pavement construction in cities throughout the middle western states, and in the last years of his practice he devoted much attention to water and sanitary structures. Mr. Champe served as a part time instructor in the college of engineering at the University of Toledo and was active on city planning and zoning bodies in Toledo.

Samuel D. Bleich, before his retirement in 1936 an assistant division engineer for the New York City board of transportation, and who had been in the service of New York city and state for 33 years, died Aug. 18 in Brooklyn. Mr. Bleich was a graduate of the College of the City of New York and held graduate degrees from Columbia University. After brief service with the Ferro Construction Co. of Cincinnati, Mr. Bleich began his public service in 1903 as an assistant engineer for the New York City department of water supply. He was employed later by the Rapid Transit Railroad Commission, the Public Service Commission, the State Transit Commission and the board of transportation. In his final connection with the board of transportation he was in charge of all details with respect to the disposition of sewers, subsurface structures, drainage and such underground services maintained during subway construction.

CALENDAR OF MEETINGS

NATIONAL SOCIETIES

Canadian Good Roads Association, annual convention, St. Andrews-by-the-Sea, N. B., Sept. 7-9.

American Association of State Highway Officials, annual convention, Boston, Sept. 27-30.

American Public Works Association, annual conference, Atlanta, October 4-6.

American Public Health Association, annual meeting, New York, Oct. 5-8.

National Council of State Boards of Engineering Examiners, annual meeting, Scranton, Pa., Oct. 11-13.

National Safety Congress, Kansas City, Oct. 11-15.

American Welding Society, annual meeting and exposition, Atlantic City, N. J., Oct. 18-22.

Canadian Institute of Sewage and Sanitation, annual convention, London, Ont., Oct. 21-22.

American Institute of Steel Construction, annual convention, White Sulphur Springs, W. Va., Oct. 27-29.

REGIONAL AND LOCAL

Section Meetings American Water Works Associations New York, Schenectady, Sept. 30-Oct. 1; Rocky Mountain, Santos Bay, N. M., Sept. 20-22; Southwest, Austin, Texas, Oct. 18-21; California, Sacramento, Oct. 20-23; Minnesota, St. Paul, Oct. 28-30; Virginia, Richmond, Nov. 4-6; Missouri Valley, Omaha, Nebr., Nov. 4-6; Wisconsin, Green Bay, Nov. 8-10.

Montana Bituminous Conference, annual conference, Glacier National Park, Sept. 7-9.

South Carolina Association of County Road Officials, annual convention, Columbia, S. C., Sept. 8-9.

New England Water Works Association, annual convention, Poland Spring, Me., September 21-24.

Rocky Mountain Sewage Works Association, first annual meeting, Santa Fe, N. M., Sept 20-23.

Texas Public Health Association, annual meeting, Dallas, Texas, Nov. 1-3.

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License Examination

Iowa: Examinations for professional engineering, Sept. 21-22 and for land surveying, Sept. 23, in the Senate Chamber at the State House, Des Moines, Iowa.

MATERIALS AND LABOR PRICES

Market quotations on construction materials and wage rates reported monthly by ENR correspondents

PRICES AS A WHOLE show no major changes this month. One-inch short leaf pine is up $1.00 to $2.00, and long leaf timbers up $5.00 in Chicago. Short leaf pine is $2.50 to $4.50 higher in Cincinnati; while pine is $1.50 to $3.50 lower and Douglas fir is $1.50 to $2.50 lower in New York. Most 2-in. pine planks are 50 cents lower in Atlanta, and fir is $1.00 to $2.00 lower in San Francisco. Seattle base price on 5/8-in. and 3/4-in. plywood is down, $68.00 and $77.60, respectively.

Vitrified pipe is lower in Cleveland and Baltimore, and so is clay drain tile in Detroit. Red lead prices are 50 cents higher in all of the twenty cities. Cement is 5 cents lower in Detroit, and 10 cents lower in Seattle. Common brick prices in New York is unsettled due to strike. Ready-mixed concrete is up 25 cents in Kansas City. Lime is up $1.00 per ton in Detroit and down 20 cents per barrel in St. Louis Paving brick is up in Baltimore and Chicago.

Increase in the rate of common labor on heavy construction from 60c./85c. to 87½c./95c. in New York City is the only labor rate change noted this month. Plasterers are on strike in San Francisco for $1.75 per hour, for 6-hour day.

CEMENT, AGGREGATES, READY-MIXED CONCRETE—F.O.B. CITY

	PORTLAND CEMENT (Per bbl., carload lots, including 40c per bbl. for bags, cash discount not included)			SAND AND GRAVEL (Per ton, carload lots)			CRUSHED STONE (Per ton, carload lots)		CRUSHED SLAG (Per ton, carload lots, f.o.b. plant)		CONCRETE (Ready Mixed 1:2:4, 50 c.y. or more, delivered)
	Cloth Bags	Paper Bags	Bulk	Gravel, 1½ in.	Gravel, ¾ in.	Sand	1½ in.	¾ in.	1½ in.	¾ in.	
Atlanta	$2.83	$2.58	$2.50	$1.65	$1.65	$1.55	$1.65	$1.75	$1.65	$1.75	$8.90
Baltimore	2.31	2.06	1.86	1.80‡	1.80‡	1.30‡	1.80‡	1.80‡	1.80‡	1.80‡	7.35
Birmingham	2.40	2.15	1.95	1.80	1.80	1.45	1.00	1.00	.90	1.15	5.45
Boston	2.25b	2.00b	1.80b	1.20	1.20	.80	1.20	1.20	....	....	7.00m
Chicago	2.45	2.20	2.05	1.00‡	1.00‡	1.00‡	1.35‡	1.35‡	1.00‡	1.00‡	....
Cincinnati	2.53	2.28	2.08	1.20	1.20	1.30	1.80	1.80	....	....	6.60
Cleveland	2.45	2.20	....	1.40	1.40	1.30	1.60	1.60	1.65	1.65	7.40i
Dallas	2.30	2.05	1.85	1.40	1.40	1.05	1.00	1.15	1.84	1.89	7.00
Denver	3.08	2.85	....	1.20	1.40	.90	....	....	....	....	....
Detroit	2.20	1.95	1.80	1.15	1.25	1.95	1.50	1.60	1.15‡	1.25‡	6.25
Kansas City	2.55	2.30	2.06	1.85	2.30	1.15	1.85	1.80	....	....	7.90n
Los Angeles	2.32	2.12	....	1.20	1.20	.90	1.20*f*	1.20*f*	....	....	6.83
Minneapolis	2.66	....	2.41	1.00k	1.00k	.25k	1.00k	1.00k	....	....	7.15j
Montreal	....	....	1.70c	.80	.85	1.15‡	1.20‡	1.30‡	....	....	6.50‡
New Orleans	2.37	2.12	....	1.50	1.50	1.25	....	....	....	....	8.00
New York	2.50‡	2.20‡	....	1.10*de*	1.10*de*	.70*de*	1.65*de*	1.75*de*	....	....	7.70
Philadelphia	2.55	2.30	2.10	1.55‡	1.65‡	1.25‡	2.00‡	2.05‡	1.00	1.00	8.25k
Pittsburgh	2.40	2.15	1.95	1.80‡	1.80‡	2.10‡	2.25‡	2.25‡	1.50	1.50	8.75
St. Louis	2.52	2.27	....	1.50‡	1.50‡	1.50‡	.85k	.85k	.65/.95*g*	.50/.85*g*	7.50
San Francisco	2.72	2.52	2.20	1.35	1.35	1.35	1.50	1.50	....	....	7.50
Seattle	3.10	2.85	....	1.17*o*	1.17*o*	1.17*o*	1.33*o*	1.33*o*	....	....	7.30*o*

‡ Delivered. *a* 10c. allowed for each returnable bag. *b* 10c. per bbl. off for cash. *c* Sales tax included. *d* Per cu. yd. *e* Barge lots alongside docks. *f* Crushed granite. *g* F.o.b. Granite City, Ill. *h* F.o.b. plant. *i* Within three miles of Public Square. *j* 5% discount for cash. *k* Discount 35c. 50c to 2000; 70c. 2000 to 5000; 95c. over 5000. *l* Up to 200 cu. yd. *m* 50c. for cash. *n* 25 c.y. or more *o* 2% off for cash.

CASH DISCOUNTS, CEMENT to Contractors: truck delivery, 2% for cash on 10th of month; on carload deliveries, no trucking, same as dealer cash discount, 10c. per bbl. for payment within 15 days of date of invoice, in Montreal 5% if payment before 15th.

CURRENT MAXIMUM PRICES RECEIVED AT CEMENT MILL

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable.

	Bagged	Bulk		Bagged	Bulk		Bagged	Bulk
Buffington, Ind.	$1.70	$1.65	Ironton, Ohio	$1.50	$1.45	Northampton, Pa.	$1.65	$1.6
Crestmore, Calif.	1.72	....	Iola, Kans.	1.70	1.65	North Birmingham, Ala.	1.75	1.7
Dallas, Tex. (Inc. 5c. tax)	1.80	1.75	La Salle, Ill.	1.70	1.65	Richard City, Tenn.	1.85	1.8
Hannibal, Mo	1.70	1.65	Limedale, Ind.	1.70	1.65	Steelton, Minn.	1.80	1.7
Hudson, N. Y.	1.75	1.70	Mason City, Ia.	1.70	1.65	Universal, Pa.	1.65	1.6
Independence, Kans.	1.70	1.65	Norfolk, Va.	1.70	1.65	Waco, Tex. (Plus 5c. Tax in Texas)	1.75	1.7

LOWER PENINSULA, MICHIGAN. Uniform carload lot cement price established March, 1937.

PAVING BRICK, BLOCKS, ASPHALT, ROAD OILS—F.O.B. CITY

	PAVING BRICKS AND BLOCKS			PAVING ASPHALT (Per ton, less than 80 penetration)		ASPHALT BINDERS—FLUXES (Per gal., 80–300 penetration)		CUTBACK ASPHALT (Per ton)		ROAD OILS (Per gal.)	ASPHALT EMULSION (Per gal.)	
	Granite per M. lots of 50,000, 4x4x8 in.	Brick per M. 3x4x8½ in., carload lots	Wood per sq. yd., 3½ in. 16-lb. treat	Tank car	Drums	Tank car	Drums	Tank car	Drums	Tank car	Tank car	Drums
Atlanta	$75.00	$38.85	$2.25	$19.00*e*	$24.00*e*	$0.0828*e*	$0.1078*e*	$.102*he*	$.137 *he*	$0.0668*e*	$0.0834	$0.0834
Baltimore	135.00	44.00‡	2.50	17.00	22.00	.075	.10	.09*h*	.125*h*	.....	.....	.....
Birmingham	.....	25.00	.....	19.00	24.00	.0878	.1128	.102*h*	.137*h*	.....	.....	.....
Boston	75.00	46.50	3.00	17.00‡	22.00‡	.07‡	.095‡	.09*h*‡	.12*h*‡	.075‡	.095‡	.125‡
Chicago	140.00	48.00	2.50	18.00	23.00	17.00*g*	22.00*g*	.07*h*	.11*h*	.05	.09	.135
Cincinnati	112.00	37.50	.....	13.47	17.47	.12	.....	17.00	.....	.051	.078	.....
Cleveland	3.75*a*	37.50	2.85	18.00	21.75	.081	.099	.091*h*	.061*h*	.06	.095	.099
Dallas	.....	32.50	.....	15.80	20.00	.05	.08	14.80	23.00	.05	.075	.105
Denver	.....	27.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Detroit	.....	35.00	.....	16.72*f*	21.97*f*	.....	20.60*g*	15.60	20.60	.0535	.1125	.1525
Kansas City	.....	44.00	.....	18.50	23.50	.077	.1075	.077*h*	.107*h*	.057	.11	.15
Los Angeles	.....	50.00	.....	11.00	15.16	11.00*g*	15.16*g*	11.00	.....	.042	.06	.12
Minneapolis	.....	.....	1.90*d*	21.70	26.70	.098	.137	21.85	34.65	.0638	.....	.....
Montreal	85.00*c*	60.00	3.42	14.00	20.00	.10	.13	.0975*h*	.01125*h*	.0675	.135	.165
New Orleans	.....	.....	.....	16.00	21.00	.075	.10	.09*h*	.125*h*	.....	.078	....
New York	138/143*b*	65.00	2.85	17.00	22.00	.075	.10	.09*h*	.125*h*	.....	.075	.11
Philadelphia	120.00	.....	.....	15.00	20.00	.06	.085	.065*h*	.095*h*	.055	.07	.10
Pittsburgh	115.00	40.00	.....	19.00	24.00	.077	.1125	.068*h*	.121*h*	.0675	.....	.....
St. Louis	115/130	37.00	.....	19.00	24.00	.075	.11	.08*h*	.115*h*	.0475	.09	.12
San Francisco	.....	70.00	.....	12.00	18.00	12.00*g*	18.00*g*	12.50	23.00	.04	.0575	.117
Seattle	.....	60.00*i*	.....	25.55	25.55	19.50*g*	25.55*g*	15.50/16.50	28.50	8.15*g*	.075	.1325

‡ Delivered. *a* 4½x6x5½ in. per sq. yd. delivered. *b* 4x5x9 in. aver. *c* Sales tax included. *d* 2½ in. 6 to 8-lb. treatment. *e* Local reduction due to 20% reduction intra-state class freight rates, only Georgia affected. *f* Mexican. *g* Per ton. *h* Per gallon. *i* 3½x4x8½ in. *Note* Paving asphalt, tank car or boat, f.o.b. Maurer, N. J., per ton, Bermudez, $25.00; Trinidad, $22.00.

(*Continued on second following page*)